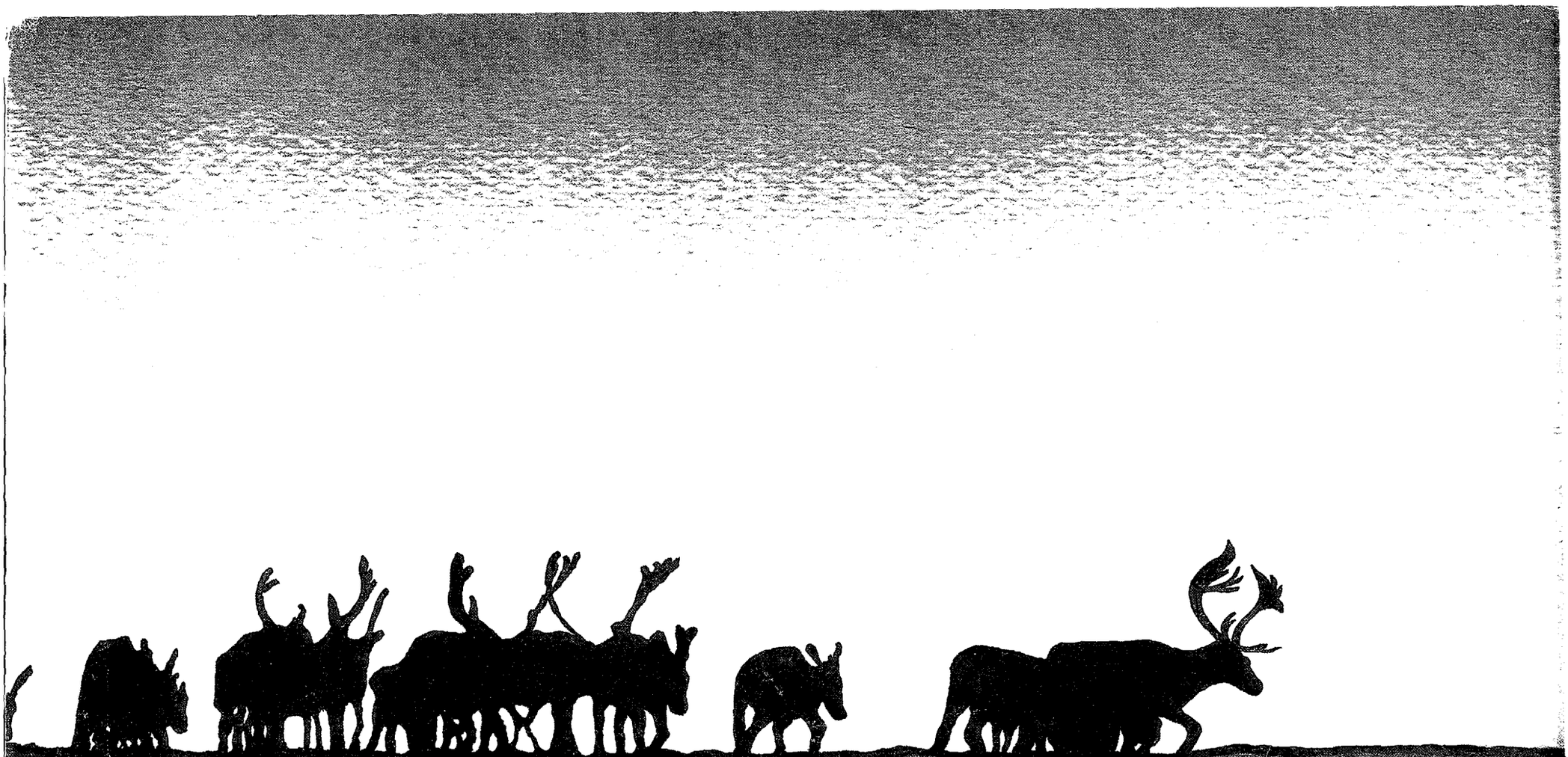
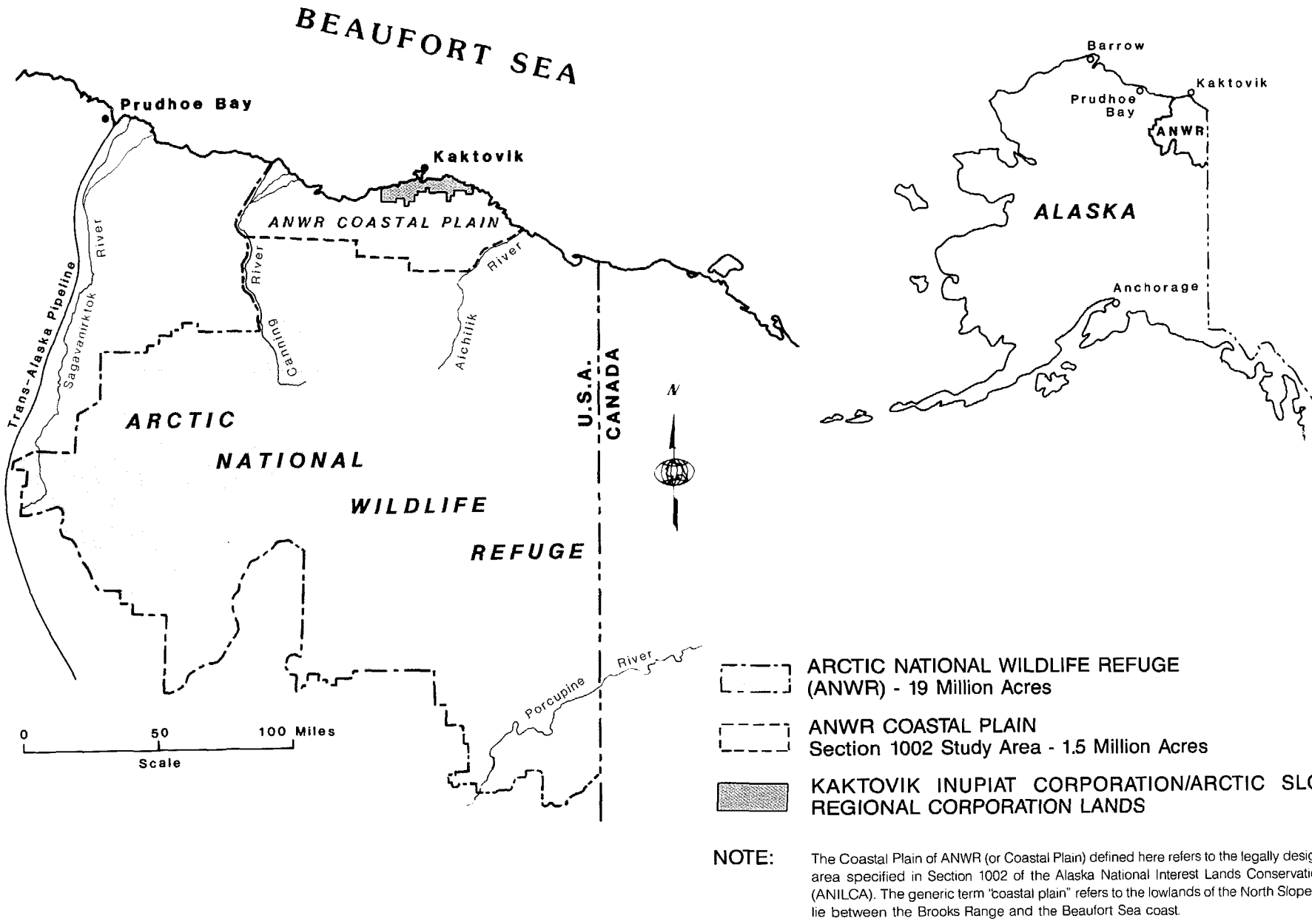


THE ARCTIC NATIONAL WILDLIFE REFUGE

Its People, Wildlife Resources, and Oil and Gas Potential



NOTE: The Coastal Plain of ANWR (or Coastal Plain) defined here refers to the legally designated area specified in Section 1002 of the Alaska National Interest Lands Conservation Act (ANILCA). The generic term "coastal plain" refers to the lowlands of the North Slope which lie between the Brooks Range and the Beaufort Sea coast.

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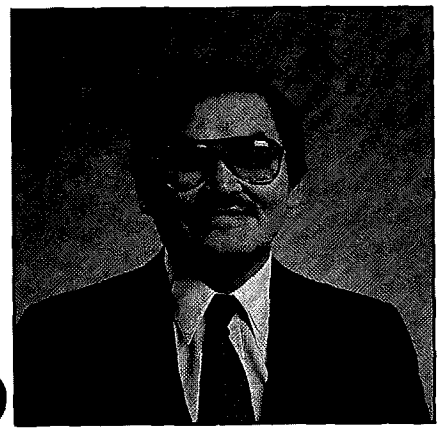

arctic slope regional corp.

Jacob Adams, President

PREFACE

Established by administrative action in 1960 as a federal conservation unit, the Arctic National Wildlife Range originally covered 8.9 million acres in northeastern Alaska. In 1980, Congress addressed the boundaries of the Range and the land management principles which should govern its future use in the Alaska National Interest Lands Conservation Act (ANILCA). Congress doubled the size of the conservation unit to about 19 million acres and redesignated the greatly expanded area as the Arctic National Wildlife Refuge (ANWR).

ANWR borders the Arctic Ocean and lies between Prudhoe Bay and the Trans-Alaska Pipeline 50 miles to the west and the United States and Canadian border to the east. In ANILCA, Congress also designated 8 million acres (approximately 45% of the expanded ANWR) as wilderness in accordance with subsection 3(c) of the Wilderness Act. Congress also identified an additional 1.5 million acres (approximately 8% of ANWR's total acreage) with high oil and gas potential in an area of ANWR near the coast of the Arctic Ocean referred to in ANILCA as the "Coastal Plain". The Coastal Plain was designated for further study of its wildlife and oil and gas resources to assist the Congress in a subsequent decision as to whether this area of promising petroleum potential should be:

1. opened to oil and gas development,
2. managed as a wilderness area; or
3. subjected to some other alternative management regime.

It is generally agreed that the 1.5 million acre Coastal Plain in ANWR contains the Nation's most promising onshore frontier area for major oil and gas prospects. Since 1980, however, all public lands in the Coastal Plain have been withdrawn from operation of the mineral leasing laws and no development may be undertaken on the Coastal Plain until expressly authorized by an Act of Congress.

The Coastal Plain also contains important fish and wildlife resources. These resources are also the subject of further study by the appropriate agencies within the Department of the Interior.

The Section 1002(h) Report

Title X of ANILCA authorized and directed a number of studies and reports on the oil and gas potential and fish and wildlife resources of the Coastal Plain of ANWR. Section 1002(h) of Title X directs the Secretary of the Interior to prepare a report together with his recommendations ". . . with respect to whether further exploration for, and the development and production of, oil and gas within the Coastal Plain should be permitted . . .". The Secretary's report is to be submitted to the Congress by September 2, 1986. Congress will be called upon to review the Secretary's report and to decide the future management regime that will govern activities on the ANWR Coastal Plain.

The Native People's Interest in ANWR

The Arctic Slope Regional Corporation (ASRC), the Inupiat Eskimo-owned Corporation established pursuant to the Alaska Native Claims Settlement Act of 1971 (ANCSA), has major cultural, subsistence, and economic interests in ANWR. One of the North Slope's eight villages within ASRC's operating area, the Village of Kaktovik, is located on Barter Island within the boundary of ANWR. ANWR has been home to Kaktovik's 210 residents and their ancestors for many centuries.

In August 1983, ASRC exchanged to the United States title to 101,000 acres of surface lands that the Corporation had previously selected under ANCSA. As a result of this exchange, the National Park Service added to the Gates of the Arctic National Park significant private inholdings, including Chandler Lake, for the use and benefit of all Americans. In return, the Department of the Interior was obligated to convey to ASRC 92,000 acres of subsurface rights underlying the surface of lands owned by Kaktovik Inupiat Corporation (KIC), the village corporation formed under ANCSA for Inupiat Eskimos of Kaktovik.

ASRC sought title to the Kaktovik subsurface because these lands are part of the most promising and prospective area for commercial oil and gas development in the United States today. As a regional corporation established under ANCSA and under State corporate law, one of the primary legal obligations of ASRC and its management is to maximize economic benefits to its shareholders. On the North Slope of Alaska, the primary economic resource is, of course, oil and gas.

It is ASRC's considered view that its subsurface estate in ANWR is highly prospective for oil and gas, as is the adjacent 1.5 million acre Coastal Plain. This view is shared by the State of Alaska, by the oil industry, by geologists, by knowledgeable observers and by the United States Geological Survey (USGS). In 1980, prior to the development of seismic and other geophysical data and information on the Coastal Plain, USGS estimated that there was a 5 percent probability that the Coastal Plain could contain up to 17 billion barrels of crude oil and 34 trillion cubic feet of natural gas undiscovered in-place; USGS also estimated that there was a mean probability that the Coastal Plain could contain up to 4.85 billion barrels of crude oil and 12 trillion cubic feet of natural gas undiscovered in-place.

ASRC's lands in the Kaktovik area represent our shareholders' best chance — perhaps their last significant chance — to participate in a meaningful way in the oil and gas development now occurring on the Inupiat Eskimo's ancestral lands. ASRC has proceeded, in recent months and years, toward the development of these lands. For example, in 1984, ASRC contracted for the drilling of a test well. Drilling operations were finally completed in April of 1986. ASRC and its contractors and consultants believe that the Kaktovik properties and the Coastal Plain should, as a matter of national policy, be opened by the Congress to further exploration and to development. This should be done under strict, but balanced, environmental regulations in which the Inupiat Eskimo people are afforded adequate opportunity for input.

In addition to these direct economic interests in ANWR, the Inupiat Eskimo residents of Kaktovik and many other Native people use ANWR and Coastal Plain lands extensively for maintaining their culture and their traditional life style, for a variety of subsistence uses and for many other purposes.

Purpose of This Document

Because of the many important interests that ASRC's more than 3,700 shareholders have in ANWR and the Coastal Plain, ASRC has had this report on ANWR prepared to provide Congress and the public with a balanced and fair appraisal of the modern history of the Inupiat Eskimo people who live in ANWR, together with detailed information on ANWR's environment, its fish and wildlife resources, and its oil and gas potential. The final section of the report reviews what is known about the interaction of oil industry development activities in the Arctic environment and what could be expected if such activities are permitted by the Congress to take place on ASRC's lands and on the Coastal Plain.

It is ASRC's hope that this report will set the tone for a balanced national debate — founded on factual information and practical experience — on the future management regime which should govern ASRC's lands and the Coastal Plain. ASRC's shareholders, the historic residents on the North Slope and ANWR, believe that, with proper regulation and enforcement, ANWR's potentially huge crude oil resources can be explored for and produced in ways that are compatible with the environment and the important fish and wildlife resources on ASRC's lands and in the Coastal Plain.

ASRC has commissioned the preparation of this report in advance of the national debate on the Secretary of the Interior's Section 1002(h) report. We did so in the hope that this report will assist the Administration, members of Congress, and the public to make informed judgments, based on relevant factual information, which will serve the national interest. ASRC believes that its shareholders' interests in ANWR's future designation and disposition — cultural, subsistence, and legal property interests — should be prominently considered when this matter is taken up by the Congress.

The Inupiat Eskimo people are subsistence hunters and users of the North Slope's fish and wildlife resources. Our people have carefully observed Prudhoe Bay's development over the past eighteen years. It is our judgment that we can have balanced and carefully regulated oil development on our lands in ANWR and in the Coastal Plain which will preserve the environment and the wildlife resources of ANWR and still benefit our people and the Nation.

Jacob Adams, President
Arctic Slope Regional Corporation
June 1986

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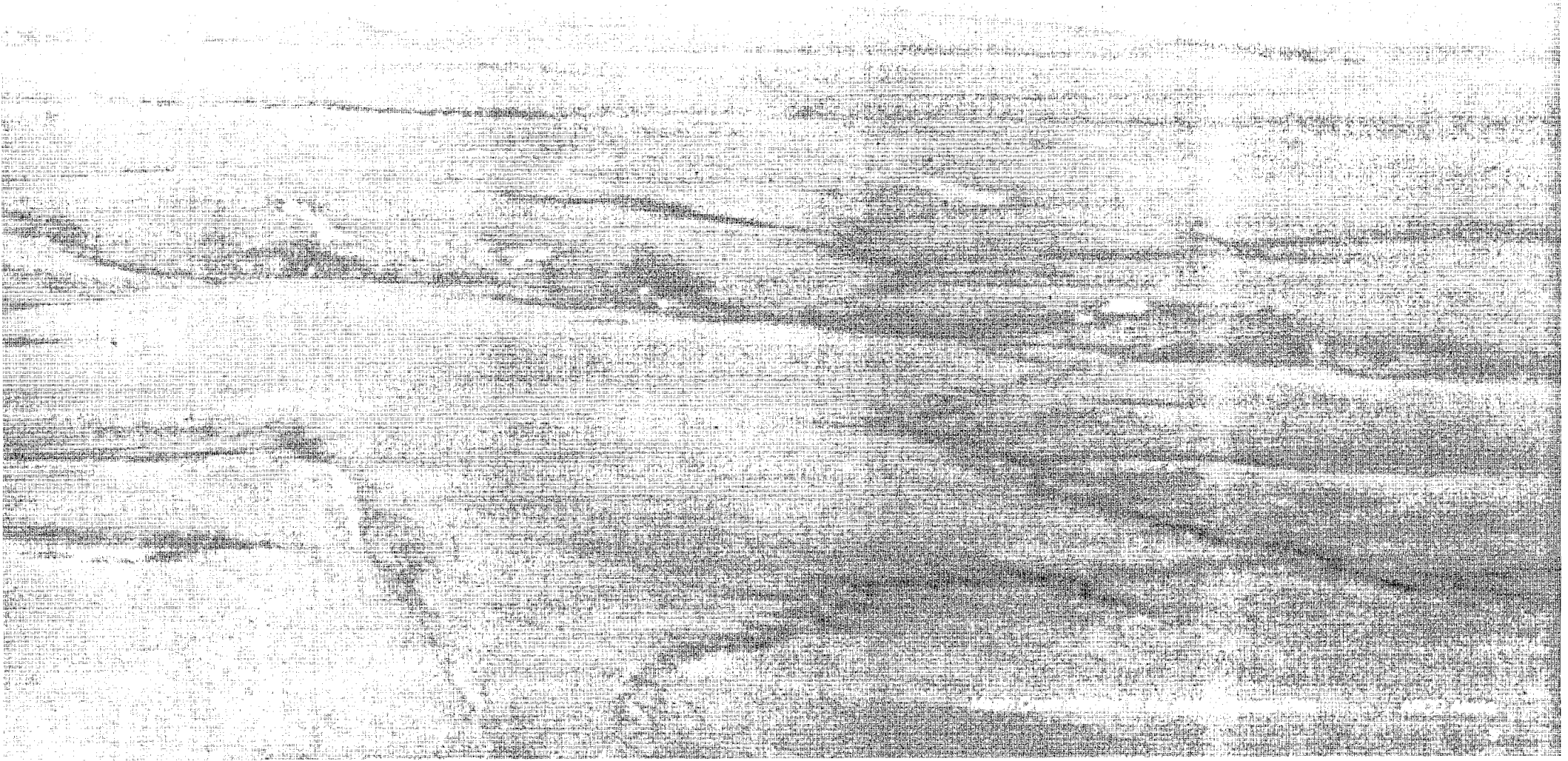

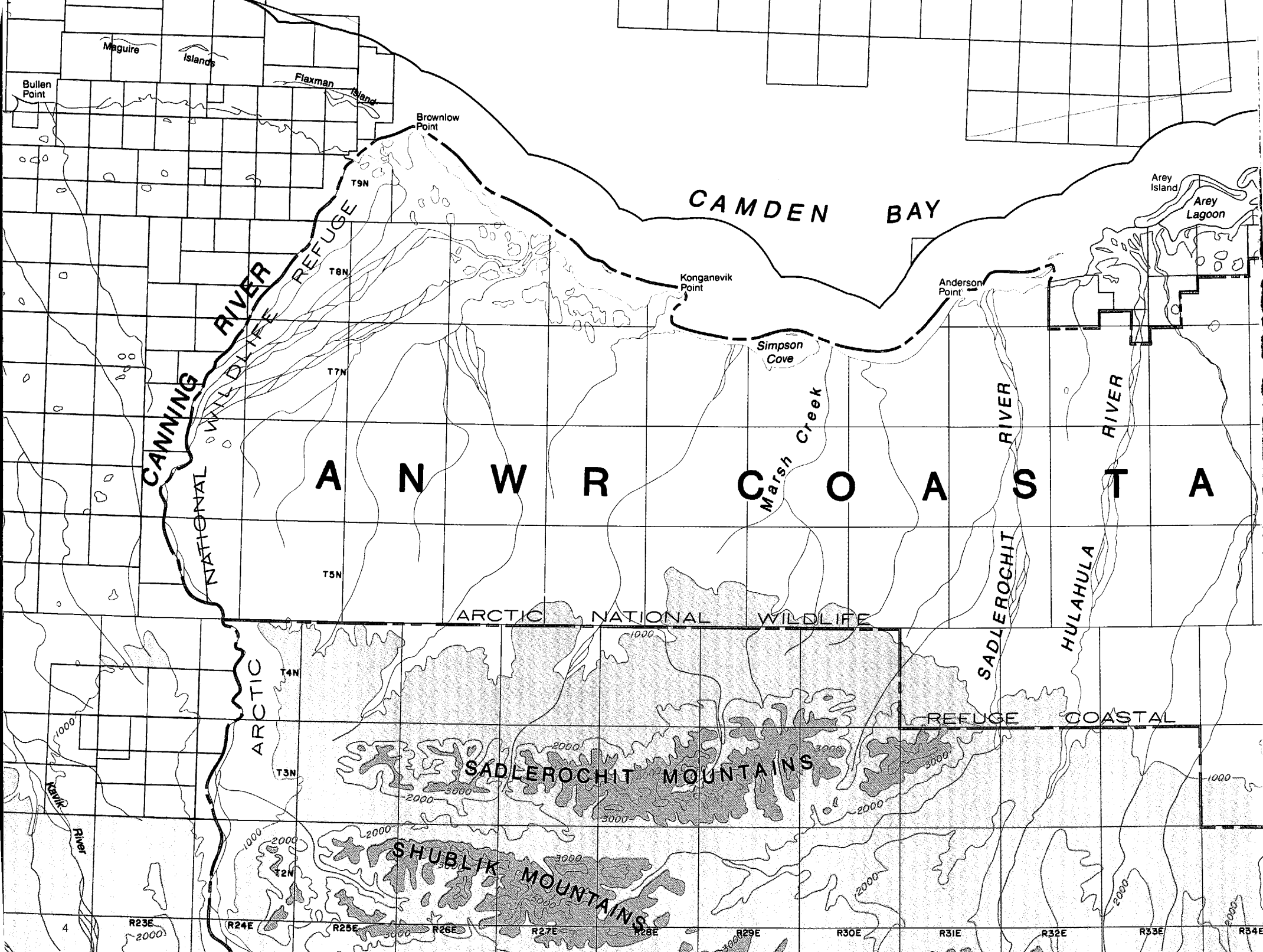
Maguire Islands
Flaxman Island
Bullen Point
Brownlow Point
CAMDEN BAY
Arey Island
Arey Lagoon
Konganevik Point
Anderson Point
Simpson Cove
Marsh Creek
CANNING RIVER
NATIONAL WILDLIFE REFUGE
ARCTIC NATIONAL WILDLIFE REFUGE
COASTAL
SADLEROCHIT RIVER
HULAHULA RIVER
SADLEROCHIT MOUNTAINS
SHUBLIK MOUNTAINS
Kavik River
T9N
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T7N
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R24E
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R26E
R27E
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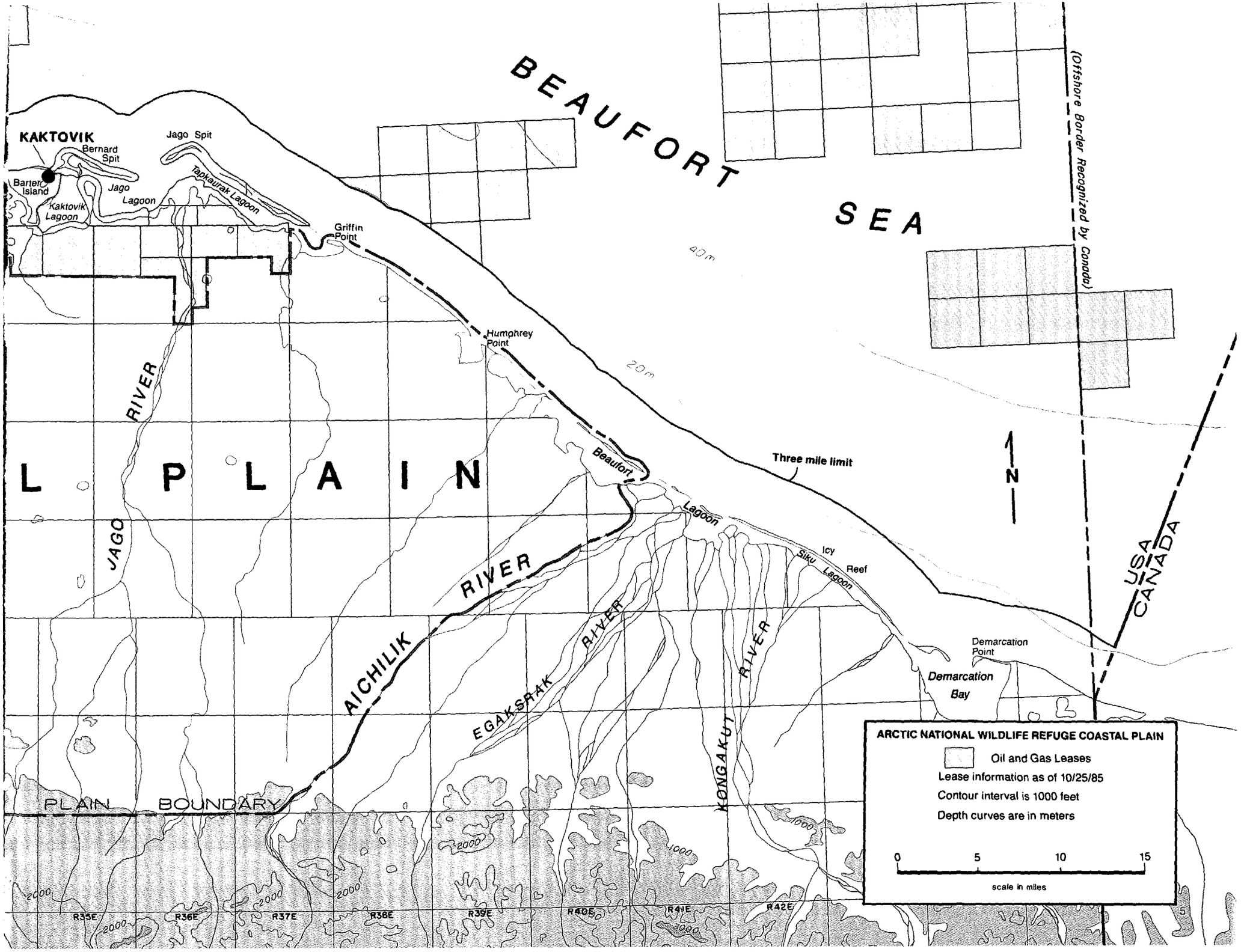

BEAUFORT SEA
(Offshore Border Recognized by Canada)
KAKTOVIK
Bernard Spit
Jago Spit
Barter Island
Jago Lagoon
Kaktovik Lagoon
Tapkaurak Lagoon
Griffin Point
40m
Humphrey Point
20m
JAGO RIVER
L P L A I N
Beaufort Lagoon
Three mile limit
N
Icy Reef
Siku Lagoon
USA
CANADA
JAGO RIVER
AICHILIK RIVER
EGAKSRAK RIVER
KONGAKUT RIVER
Demarcation Point
Demarcation Bay
PLAIN BOUNDARY
2000
1000
R35E
R36E
R37E
R38E
R39E
R40E
R41E
R42E
ARCTIC NATIONAL WILDLIFE REFUGE COASTAL PLAIN
Oil and Gas Leases
Lease information as of 10/25/85
Contour interval is 1000 feet
Depth curves are in meters
0 5 10 15
scale in miles

Grave marker in the Coastal Plain. *USFWS*

Wolf track remains after loose snow is blown away.

the Refuge. However, Congress will soon reconsider the issue in one of the most important land use decisions in U.S. history.

Congress recognized both renewable and nonrenewable resources in ANWR when it passed the Alaska National Interest Lands Conservation Act of 1980 (ANILCA). In dealing with ANWR, Section 1002 of the Act specified that about 1.5 million acres of the Coastal Plain (about 8 percent of the 19 million acre refuge) should be subject to a thorough resource evaluation. About half the refuge or approximately 8 million acres was set aside by ANILCA as wilderness and is not subject to the resource evaluation. Recognizing the high potential for oil and gas deposits along with important fish and wildlife resources, Congress required a comprehensive and continuing inventory and assessment of the biologic resources of the Coastal Plain and an analysis of the potential impacts of oil and gas exploration, development and production. ANILCA also allowed limited geologic and geophysical surveys to provide a better understanding of ANWR's oil and gas potential. Under the terms of the Act, the U. S. Fish and Wildlife Service was given the mandate to conduct the assessment; a report on the findings is to be submitted to Congress by September 1986.

While ANILCA required special evaluations in the ANWR Coastal Plain before oil and gas leasing could be carried out, it is important to note that similar activities have been permitted in other refuges as a matter of course. Fish and Wildlife Service refuge management regulations allow for oil and gas extraction if it is considered to be in the national interest and is compatible with the purposes for which a refuge was established. One example of oil and gas development within a refuge is the Swanson River Field within the Kenai National Wildlife Refuge (formerly the Kenai National Moose Range) where oil has been produced for more than twenty-five years without significant adverse environmental effects.

The decisions to be made about opening the ANWR Coastal Plain to exploratory drilling and potential petroleum development will be controversial. The purpose of this booklet is to provide an overview of the environment of ANWR, its history, and its petroleum potential.

Land Management Legislation Affecting ANWR

Disposition of Federal lands in Alaska has been the subject of intense debate since the 1950s. In 1959, the Alaska Statehood Act granted title to approximately 28 percent of Alaska's land mass (about 104 million acres) to the new state, to be selected over a period of years. The following year (1960), the Arctic National Wildlife Range was established for the purpose of preserving unique wildlife, wilderness, and recreational values while at the same time allowing for oil and gas leasing; the initial withdrawal involved approximately 8.9 million acres. The same land order opened the region between the Colville and Canning Rivers to selection under the Statehood Act and to homesteading. The State of Alaska selected considerable acreage in the region, including the lands where the Prudhoe Bay and Kuparuk oil fields were later discovered. Land transfers ceased, however, when the Secretary of the Interior issued a land freeze in 1967, blocking further State selections until Native land claims were settled four years later.

During the eight years between passage of the Alaska Statehood Act and the Department of the Interior's 1967 land freeze, title to approximately 12 million acres of public land was transferred to the State. Further land transfers within the state remained "frozen" until 1971 when Congress passed the Alaska Native Claims Settlement Act (ANCSA). Granting to

King Eider.

Alaska Natives land selection rights to over 40 million acres, ANCSA paved the way for construction of the Trans-Alaska Pipeline and allowed State selections to resume. Section 17(d)(2) of the Act, popularly known as "D-2", authorized the Secretary of the Interior to withdraw up to 80 million acres of land for inclusion in national parks, wildlife refuges, forests, and wild and scenic rivers.

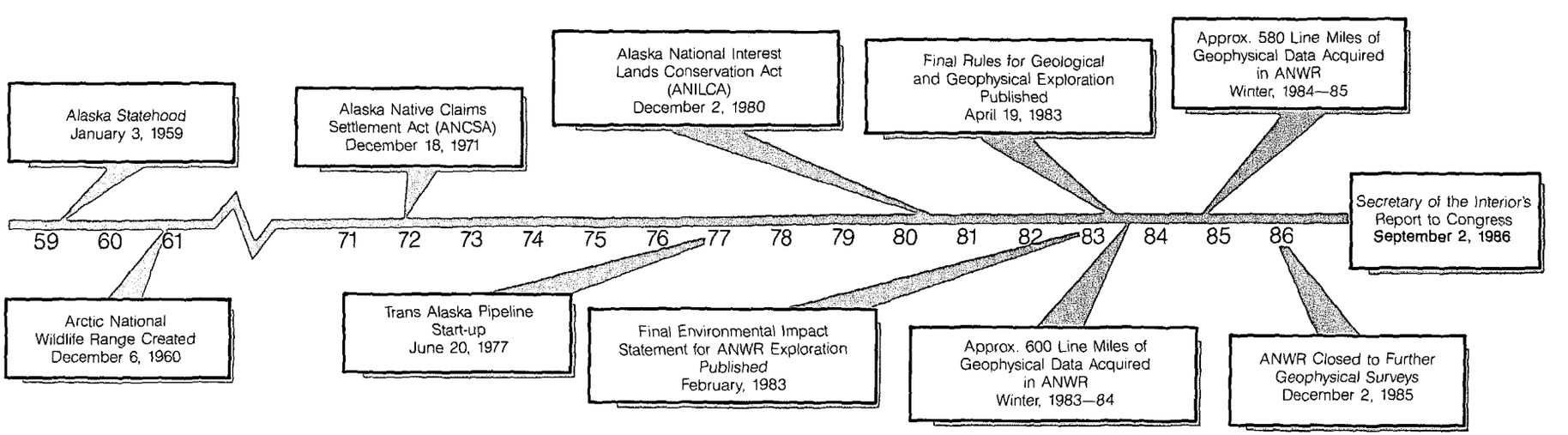
Although ANCSA opened Alaskan lands to State and Native selections for a brief time, a series of freezes were imposed on Federal land transfers until the D-2 withdrawals were accomplished. Following intense debate regarding management of Federal lands in Alaska, Congress passed the Alaska National Interest Lands Conservation Act (ANILCA) on December 2, 1980, ending an era of uncertainty. ANILCA changed ANWR's name to the Arctic National Wildlife Refuge and added about 9 million acres to double the size of the Refuge to approximately 19 million acres.

ANILCA reiterated the purposes for which ANWR was established including conservation of fish and wildlife populations and their habitats, fulfillment of international treaty obligations relating to migratory wildlife, continuation of subsistence uses by local residents, and maintenance of water quality. Congress required [in Sec. 304(a)] that administration of the Refuge be in accordance with laws governing the National Wildlife Refuge System and required [in Sec. 304(g)] preparation of a comprehensive conservation plan for ANWR. The Coastal Plain was specifically addressed in Sec. 1002 which required the Secretary of the Interior to report to Congress on the following issues:

- identification by means other than drilling exploratory wells of the oil and gas potential of the ANWR Coastal Plain
- description of fish and wildlife, their habitats, and other resources within areas having oil and gas potential
- evaluation of adverse effects of further oil and gas exploration and production on wildlife and their habitats
- identification of transportation systems for oil and gas development
- evaluation of the national need for development of ANWR oil and gas resources
- recommendations with respect to whether further exploration for, and the development and production of, oil and gas within the Coastal Plain should be permitted and, if so, what legal authority is necessary to ensure that the effects of these activities on wildlife and other resources are avoided

Geophysical surveys authorized under Section 1002 of ANILCA had to be completed before December 2, 1985, five years after the law passed. From that time, the Secretary of the Interior had nine months (until September 2, 1986) to complete his report. Pending litigation may delay submission of the report to early 1987. Until Congress takes action, no production of oil and gas from ANWR is allowed, and no leasing or development leading to production shall take place.

IMPORTANT DATES IN ANWR LEGISLATIVE HISTORY

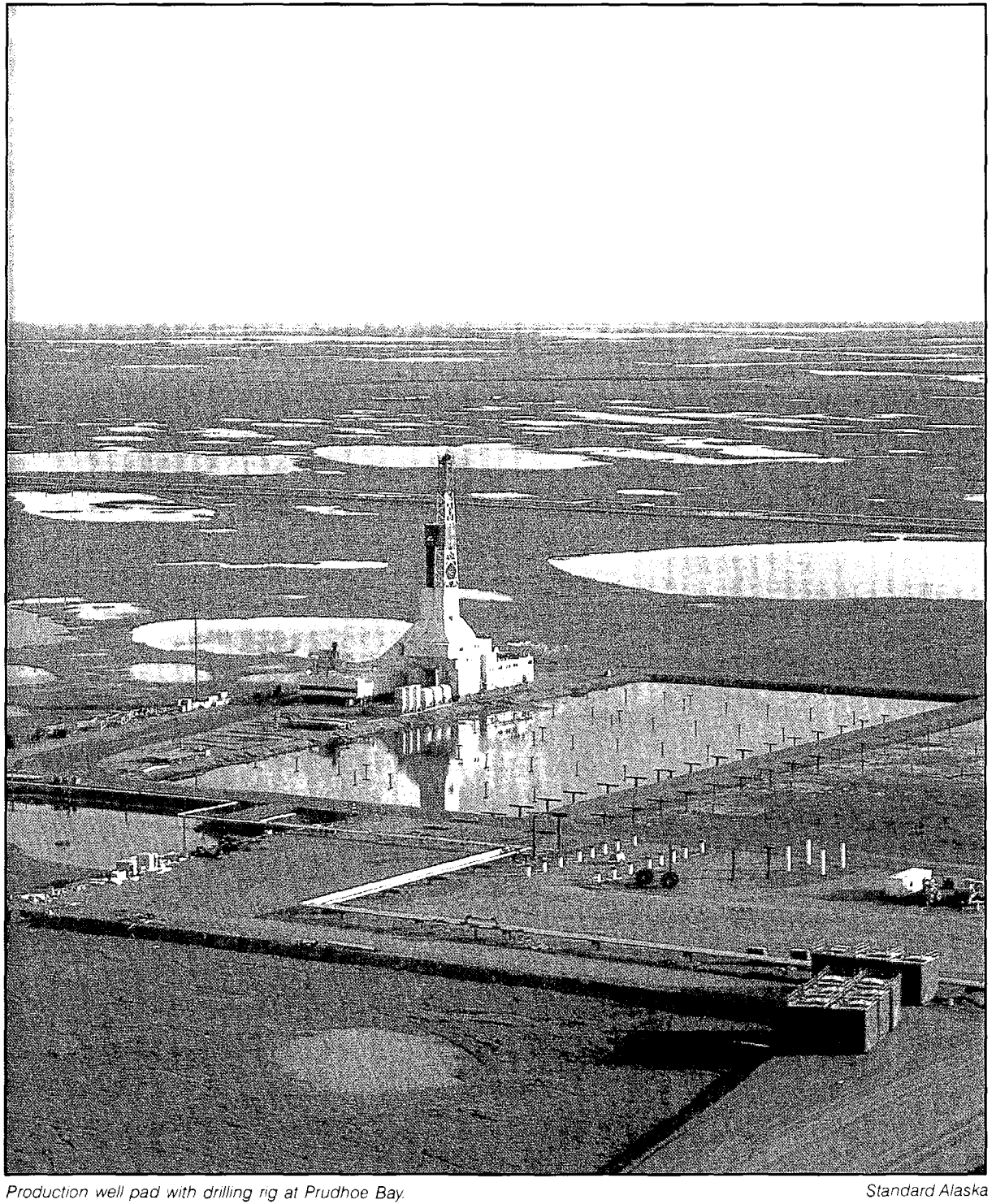


Forty Years of Oil and Gas Activity in the Arctic

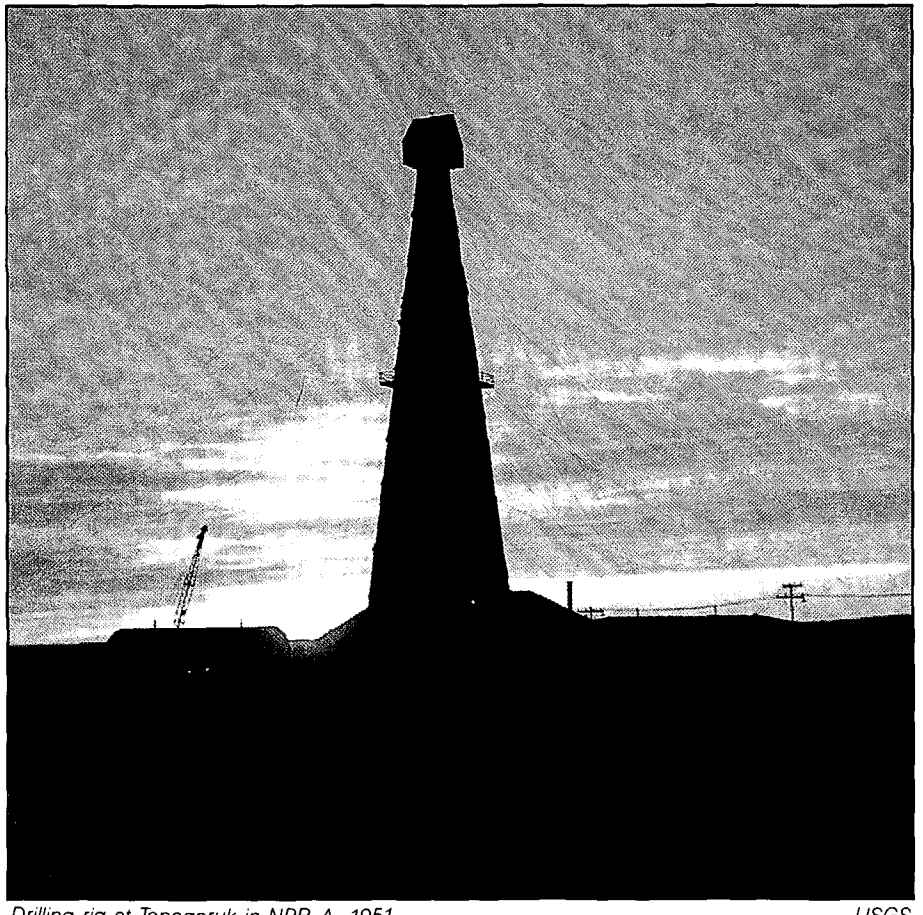
The high potential for significant discoveries of oil and gas in ANWR has long been recognized. Early explorers of the region, such as Leffingwell at the turn of the century, found oil seeps and oil-stained sands. However, since ANWR was established in 1960, exploration in the region has been restricted to surface geological investigations, aeromagnetic surveys, and two winter seismic surveys (in 1983-84 and 1984-85) conducted as part of the ANILCA-permitted evaluation of oil and gas potential. No exploratory drilling has been accomplished in the area except for one well commenced in the winter of 1984-85 on Kaktovik Inupiat Corporation and Arctic Slope Regional Corporation lands southeast of Kaktovik, just outside the ANWR Coastal Plain. In contrast, nearly 250 onshore exploration wells have been drilled elsewhere on the North Slope, with another 44 drilled offshore in the Beaufort Sea. This exploration effort west of ANWR has resulted in discovery of the largest oil field in North America along with several other discoveries of significance.

Oil and gas exploration in the Arctic began in earnest in 1944 in the Naval Petroleum Reserve No. 4 (now National Petroleum Reserve-Alaska, NPR-A), which lies in northwestern Alaska, under a program conducted by the Navy. As a result of those drilling efforts (a total of 36 wells), several small, sub-economic oil and gas fields were discovered. There was a hiatus in exploration from 1953 until 1974, when the Navy resumed exploration. The program was subsequently transferred to the Department of the Interior in 1977, and by 1980, 24 additional wells had been drilled in NPR-A. The first NPR-A lease sale was held in 1982, but to date there have been no significant discoveries.

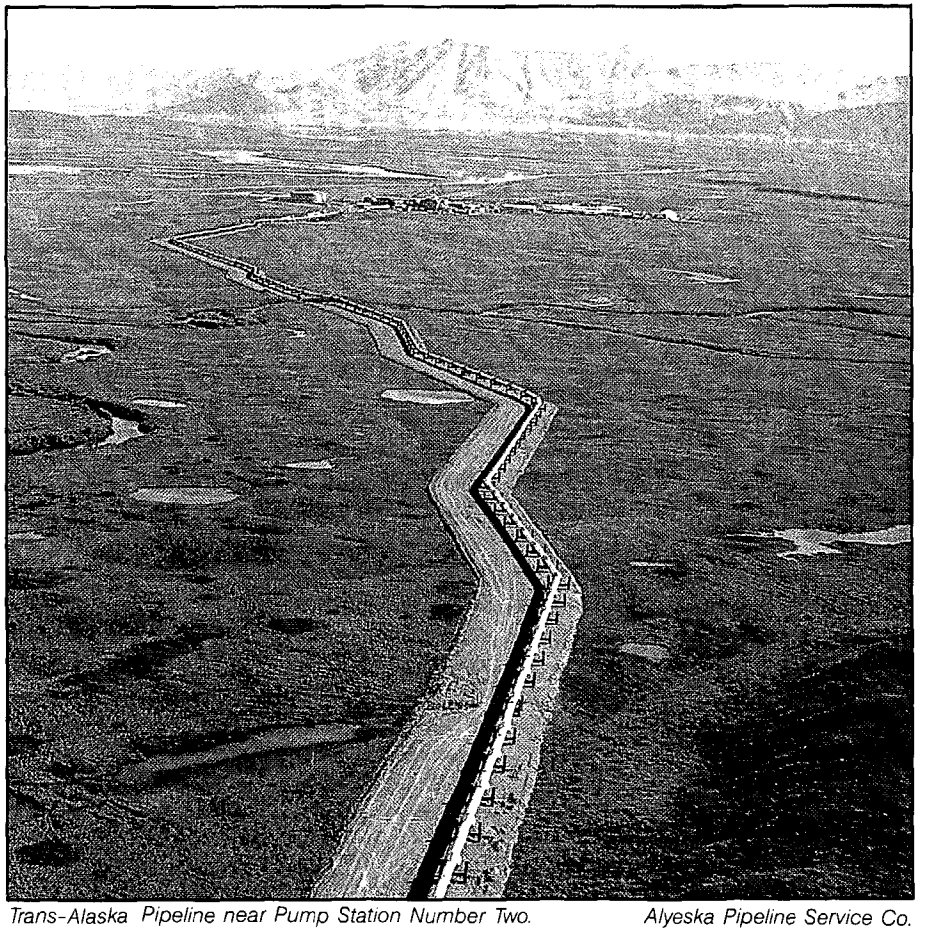
Outside NPR-A, the pattern of petroleum exploration and development on the North Slope (and more recently in the Beaufort Sea) has been influenced more by the availability of land (and its antithesis — land freezes) than geologic potential. The picture of petroleum development in the mid-1980s shows



Production well pad with drilling rig at Prudhoe Bay. *Standard Alaska*



Drilling rig at Topagoruk in NPR-A, 1951. *USGS*



Trans-Alaska Pipeline near Pump Station Number Two. *Alyeska Pipeline Service Co.*

major producing fields, yet to be produced fields and significant discoveries west of ANWR (both onshore and offshore) and major discoveries in the Canadian Beaufort Sea and Mackenzie Delta area to the east. These occur in similar geologic trends and sedimentary deposits to those that lie beneath ANWR.

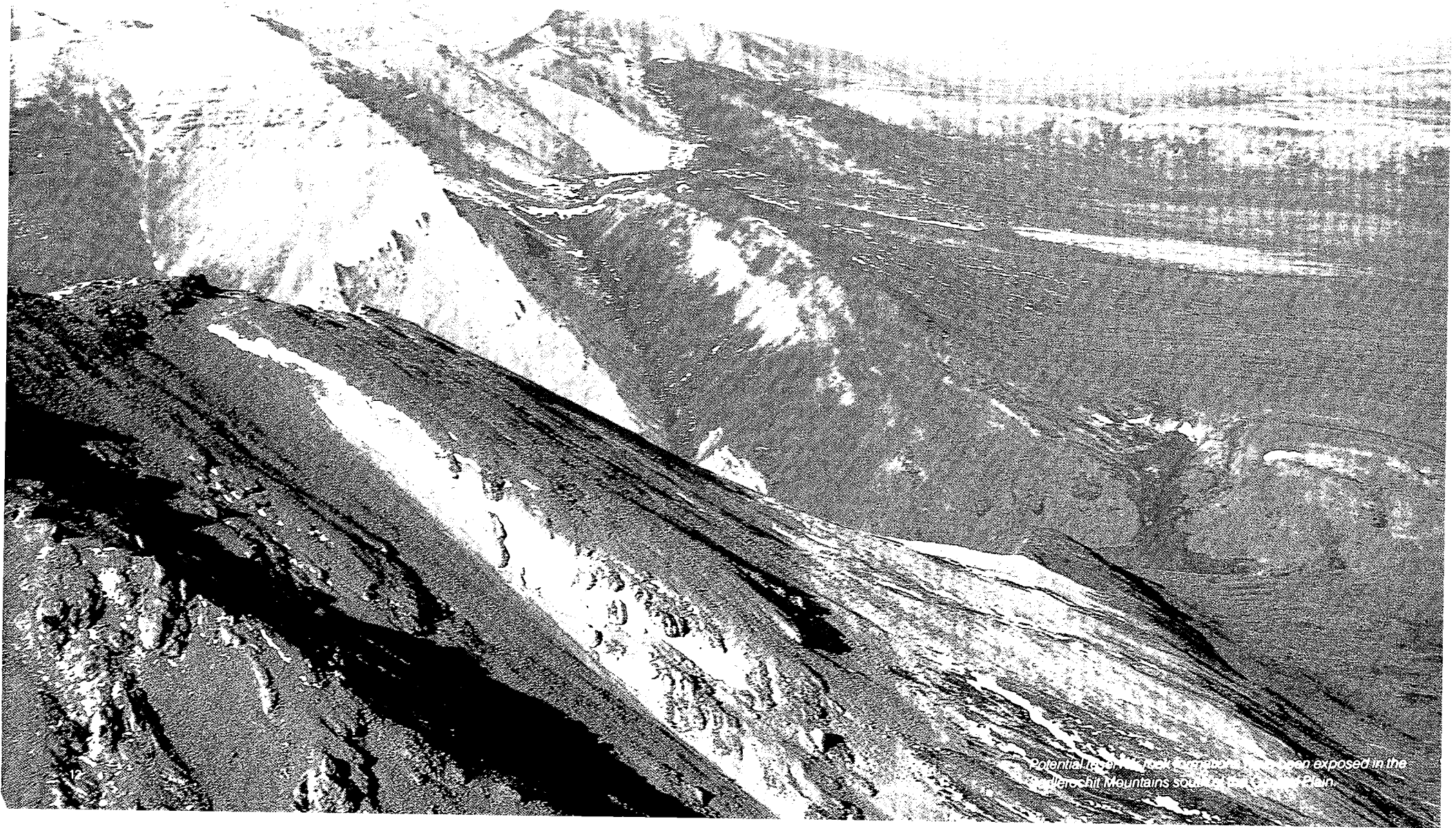
Exploration by oil companies on Federal and State lands east of the Colville River in the 1960s culminated in the discovery in 1968 of the Prudhoe Bay oil field, the largest in North America, with original producible reserves of 9.6 billion barrels. Production, however, was delayed until concerns regarding Native land claims and the potential environmental impacts of the proposed Trans-Alaska Pipeline could be resolved. Pipeline construction started in 1974 and Prudhoe Bay production began in 1977. The adjacent Kuparuk field (with reserves of over one billion barrels) came on line in 1982, followed by the smaller Milne Point field in 1985. Together these fields are producing about 1.7 million barrels of oil per day, or approximately 20 percent of U.S. domestic production. Prudhoe Bay production will decline, however, in the late 1980s and no more new oil fields have yet been discovered with sufficient resources to compensate for that decline.

Exploration offshore in the Beaufort Sea began in the mid-1970s on State leases in shallow water. In 1978, the Endicott field was discovered near the Sagavanirktok River Delta and construction of production facilities began in 1985. The field, with estimated recoverable reserves of 350-400 million barrels, is scheduled to begin production in 1987, nine years after its discovery.

The pace of offshore exploration accelerated following the Joint State-Federal Lease Sale BF in 1979. Subsequently, there have been two additional Federal sales in the Beaufort Sea — Sale 71 in 1982 and Sale 87 in 1984. Two discoveries have been announced in Sale 71 and exploration in the Sale 87 area, which includes highly prospective tracts offshore of ANWR, began in the summer of 1985. State lease sales within the three-mile limit along the seaward boundary of ANWR have been scheduled in the Camden Bay area in May 1987, and near Demarcation Point in May 1988.

Important Geologic Features of ANWR

The coastal plain of the Arctic National Wildlife Refuge is generally regarded as the most prospective region for major oil fields which still remains unexplored in the United States. In addition to having favorable geology, ANWR lies between areas where significant discoveries have already been made. On the western border of ANWR a number of wells have discovered gas and condensate indicating a large accumulation in the Pt. Thomson area. To the east, in the Mackenzie Delta, over 7 trillion cubic feet of natural gas have been discovered along with several large oil fields. Also to the east, in the Canadian Beaufort Sea, major oil discoveries have been made, and the recently announced discovery at the Amauligak I-65 well probably represents a commercially producible field. The Alaskan oil and gas fields are located along geologic trends that extend through the coastal plain of ANWR and which exhibit similar geological characteristics to the older rocks of the Prudhoe Bay/Endicott fields in the west, and to the younger rocks of the Pt. Thomson area. Such favorable regional comparisons go a long way towards explaining the optimistic assessments of the oil potential of ANWR.



Potential [illegible] have been exposed in the Sadlerochit Mountains south[illegible] Plain.

The principal geologic ingredients necessary for the formation of large oil and gas fields are believed to exist in ANWR. These include:

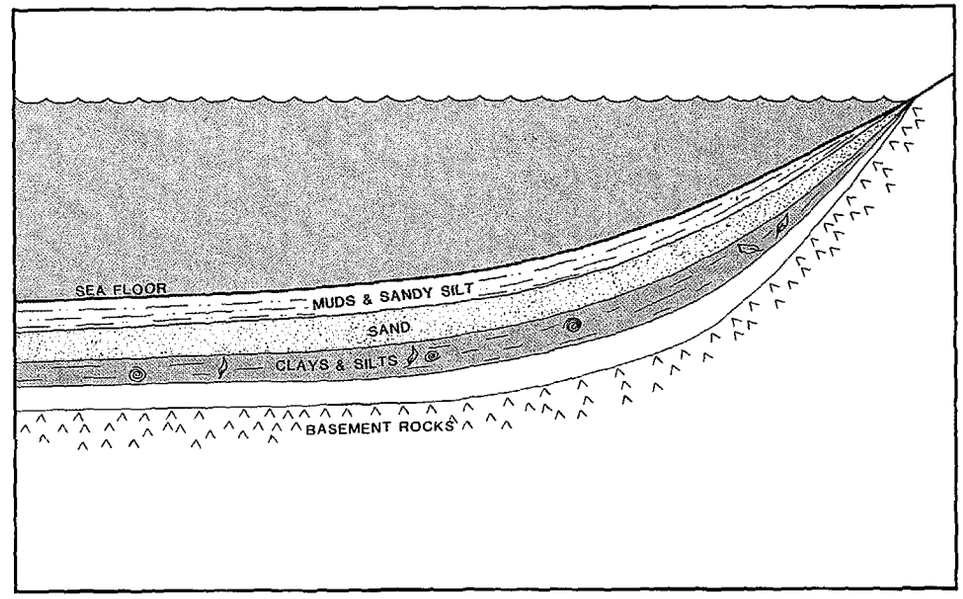
1. Source rocks, formed in part from organic materials of decaying animal and vegetable matter, that when buried and subject to high temperatures and pressures, form petroleum;

2. thick sequences of reservoir rocks such as sandstones and limestones in which petroleum can move and accumulate;

3. large geologic structures (traps) in which petroleum can accumulate, with an accompanying adequate seal (cap rock) to prevent its escape; and

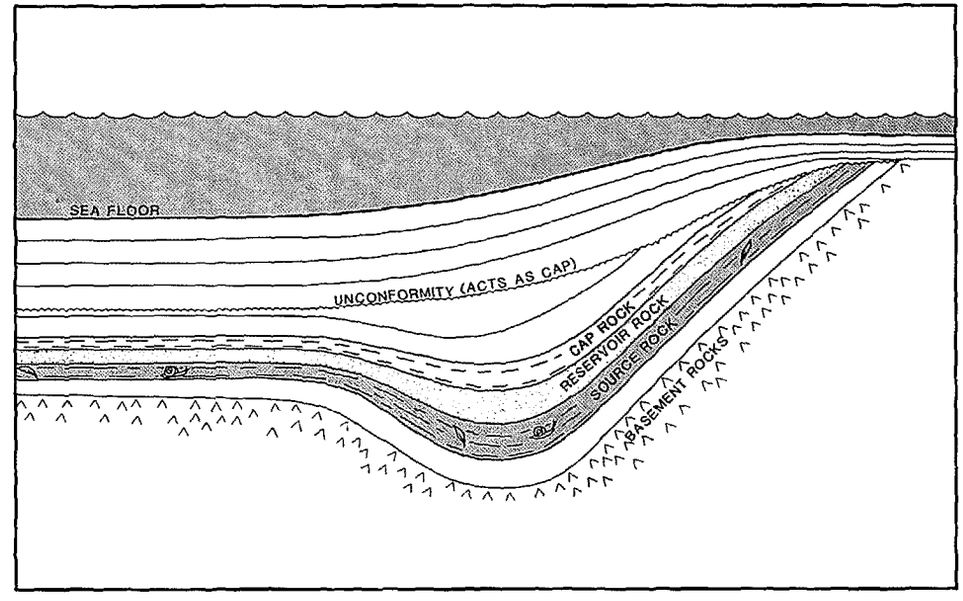
4. a favorable geologic history involving a sequence of events that allowed oil and gas to form, migrate, accumulate and be trapped, without escaping to the surface.

SEDIMENTARY BASIN DEPOSITS



Deposition of sediments in ocean basins forming parent materials for reservoir and source rocks.

FORMATION OF SOURCE ROCK, RESERVOIR ROCK AND CAP ROCK



Burial and compaction of sediments in subsiding basins converts sediments to rock and organic materials to oil and gas under high pressures and temperatures. Impermeable rock above reservoir rock forms a cap which traps oil and gas.

The sedimentary rocks in ANWR include both highly organic source rocks, such as the "Pebble Shale", which is probably the principal source of Prudhoe Bay oil and gas, and thick sequences of reservoir rocks which are already established as reservoirs to major hydrocarbon accumulations in fields immediately to the west of the Refuge. Major geologic structures for trapping oil and gas exist in ANWR including several large anticlines. The most well known of these is the 40-mile long Marsh Creek anticline which trends west-southwest of Barter Island.

There are also numerous oil seeps on the coastal plain of ANWR which confirm the presence of oil producing formations at depth indicating that oil has been generated in the region and that it has migrated. However, it is not known whether it has been trapped and accumulated into a giant oil field. Only exploratory drilling will confirm that.

SEDIMENTARY ROCK SEQUENCES IN ANWR (Stratigraphic Column)

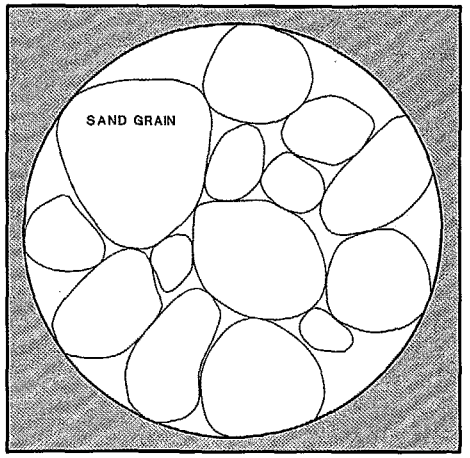
Sequence	Geologic Age	Millions Years	Formation	Known Fossil Fuels' Oil	Known Fossil Fuels' Gas
Brookian	Tertiary	63	Sagavanirktok Formation	●	●
	Cretaceous (upper)	32.5	Colville Group	●	●
	Cretaceous (lower)	46.5	Nanushuk Group		
Ellesmerian			Kongakut Formation — "Pebble Shale"		
	Jurassic	69	Kuparuk River Sandstone Kingak Shale	●	●
	Triassic	35	Shublik Formation — Karen Creek Sandstone	●	●
	Permian	38	Sadlerochit Group	●	●
	Pennsylvanian	34	Lisburne Group	●	●
	Mississippian	40			
			Endicott Group	●	●
Franklinian	Devonian and Older		Sediments and Metasediments; Volcanics and Metavolcanics		

Notes: 1. Discoveries outside ANWR

Unconformities (major erosion events)

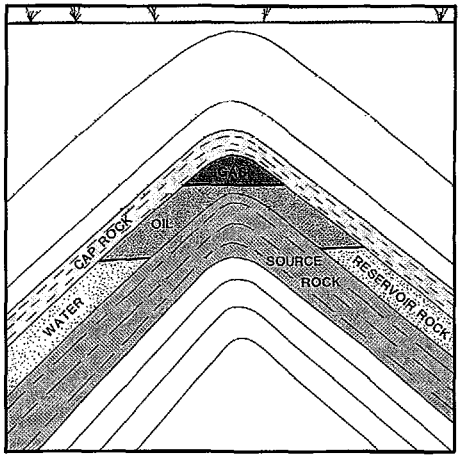
Source: U.S. Geological Survey, Open File Report No. 78-489

A SANDSTONE RESERVOIR ROCK



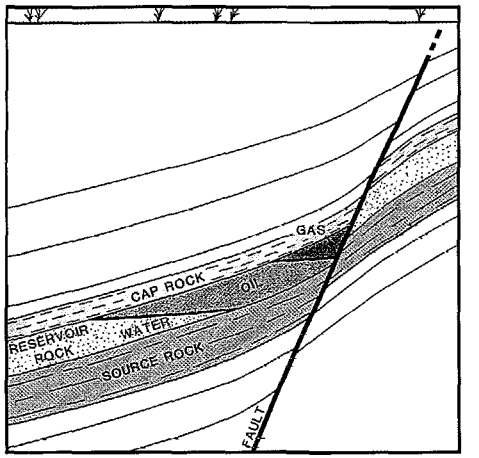
Oil occurs in the porous voids in sandstone reservoir rocks. During production, oil flows through the channels between rock grains to the well bore.

ANTICLINAL TRAP



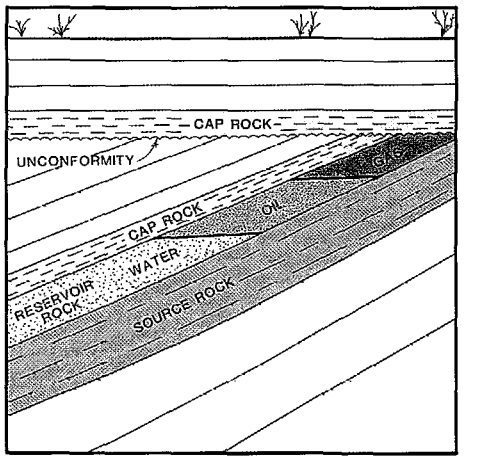
Oil and gas migrate and are trapped in an upward fold of the rock strata. In the trap, lighter gas moves to the top, underlain by oil, with water occurring beneath.

FAULT TRAP



Fracture and shifting of rock strata places impermeable rock adjacent to reservoir rock, trapping hydrocarbons. Also, fault gouge materials form a barrier to migrating oil and gas.

STRATIGRAPHIC TRAP



Inclined beds of sedimentary rocks are truncated by erosion forming an "unconformity". Impermeable rocks deposited later form a cap to the reservoir.

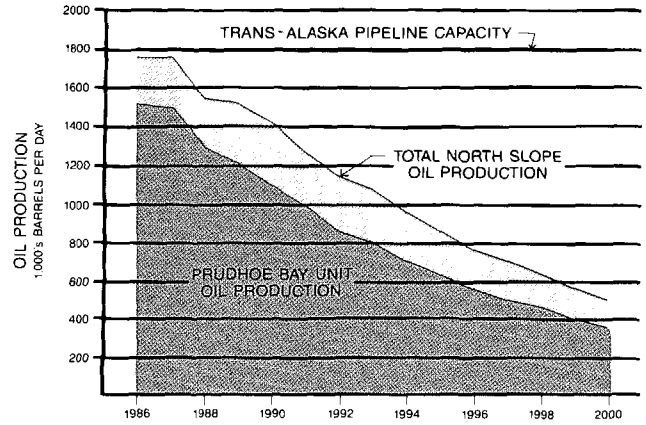
Estimates of ANWR Oil and Gas Potential

Oil industry, State, and Federal oil and gas resource estimates for ANWR have been consistently very high, indicating a potential in excess of one third of the current U. S. oil reserves and probably more than the initial reserves at Prudhoe Bay. ANWR may rank above the Beaufort Sea, central and southern California, and the deeper waters of the Gulf of Mexico, as a major potential petroleum province that could contribute significantly to the Nation's energy supplies in the 1990's when production from other areas, including Prudhoe Bay, declines.

Exploration and development of Arctic oil and gas usually takes more than ten years from the initial discovery of oil to first production. Consequently, any production from this area is not likely to occur much before the end of this century. At that time production from current U.S. reserves is expected to have declined considerably from the present level of over 8 million barrels of oil per day (bopd) to less than 3 million bopd, and Prudhoe Bay production which in 1986 is averaging 1.5 million bopd will have declined (according to the State of Alaska, Department of Revenue) to 280,000 bopd in the year 2000. To compensate for this loss of production new discoveries of domestic oil must be developed or imports must be increased.

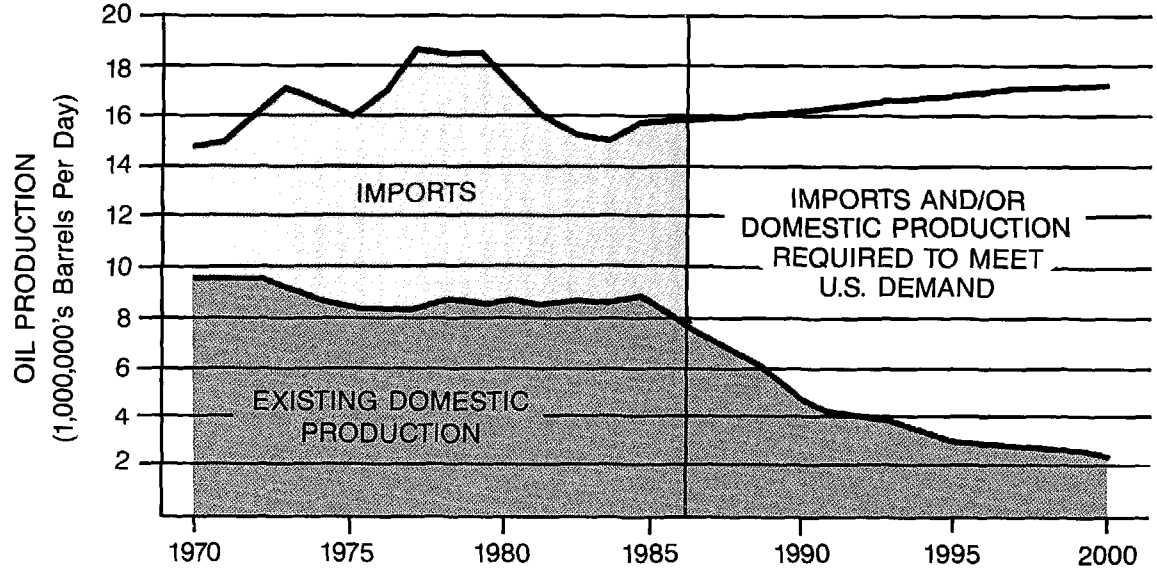
The geologic indicators are very favorable for the presence of significant oil and gas resources in ANWR, but the limited data means that there is a high level of uncertainty about how much oil and gas may be present. Consequently, current estimates represent the best scientific guesses. However, most geologists agree that the potential is on the order of billions of barrels of recoverable oil, and trillions of cubic feet of recoverable gas and that these resources may rival the initial reserves at Prudhoe Bay. Federal government estimates are currently being revised and are anticipated to be included in the ANILCA 1002 studies which are to be completed in the fall of 1986. The validity of these estimates can only be proved by drilling exploratory wells.

PRUDHOE BAY AND OTHER NORTH SLOPE OIL PRODUCTION

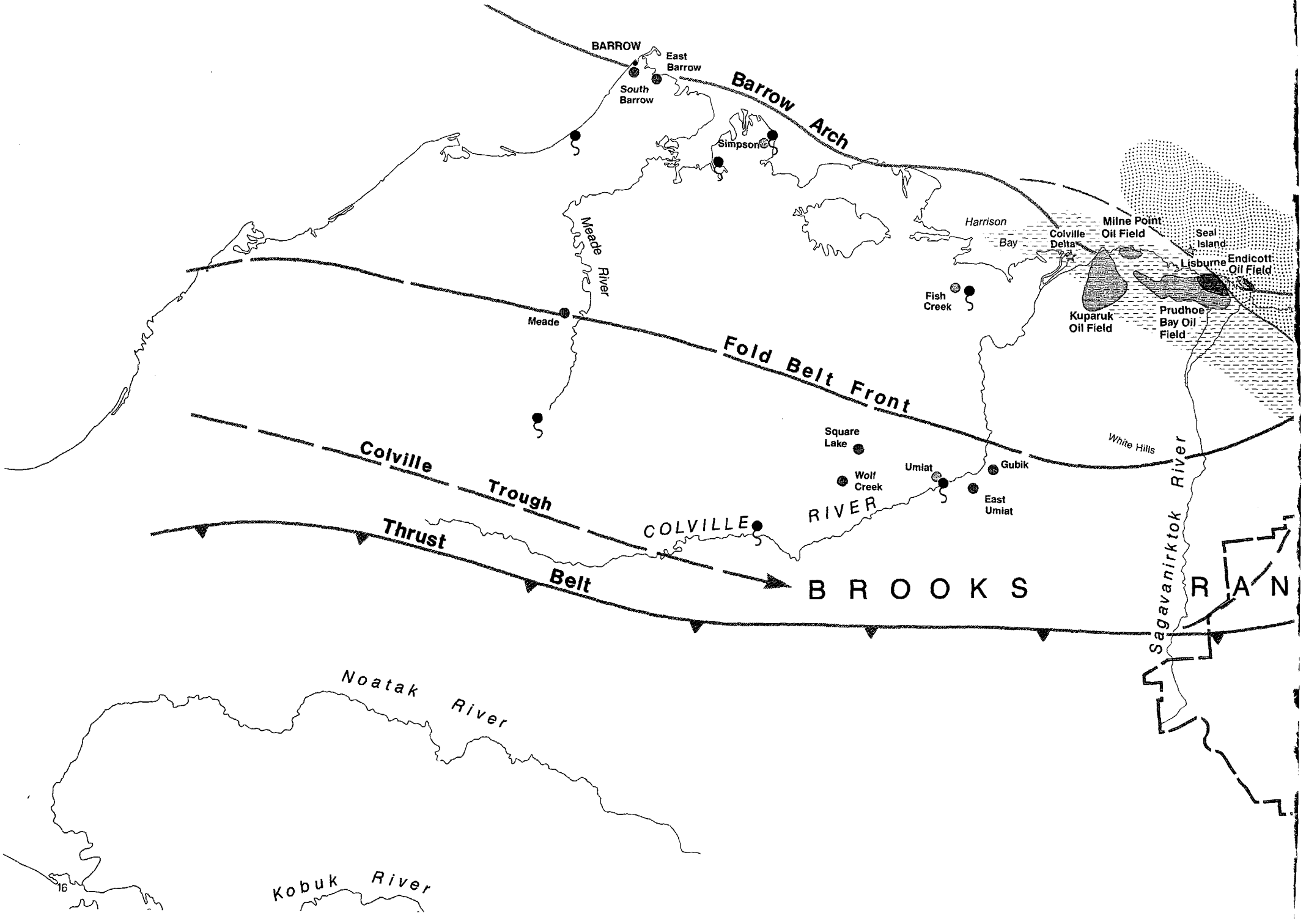


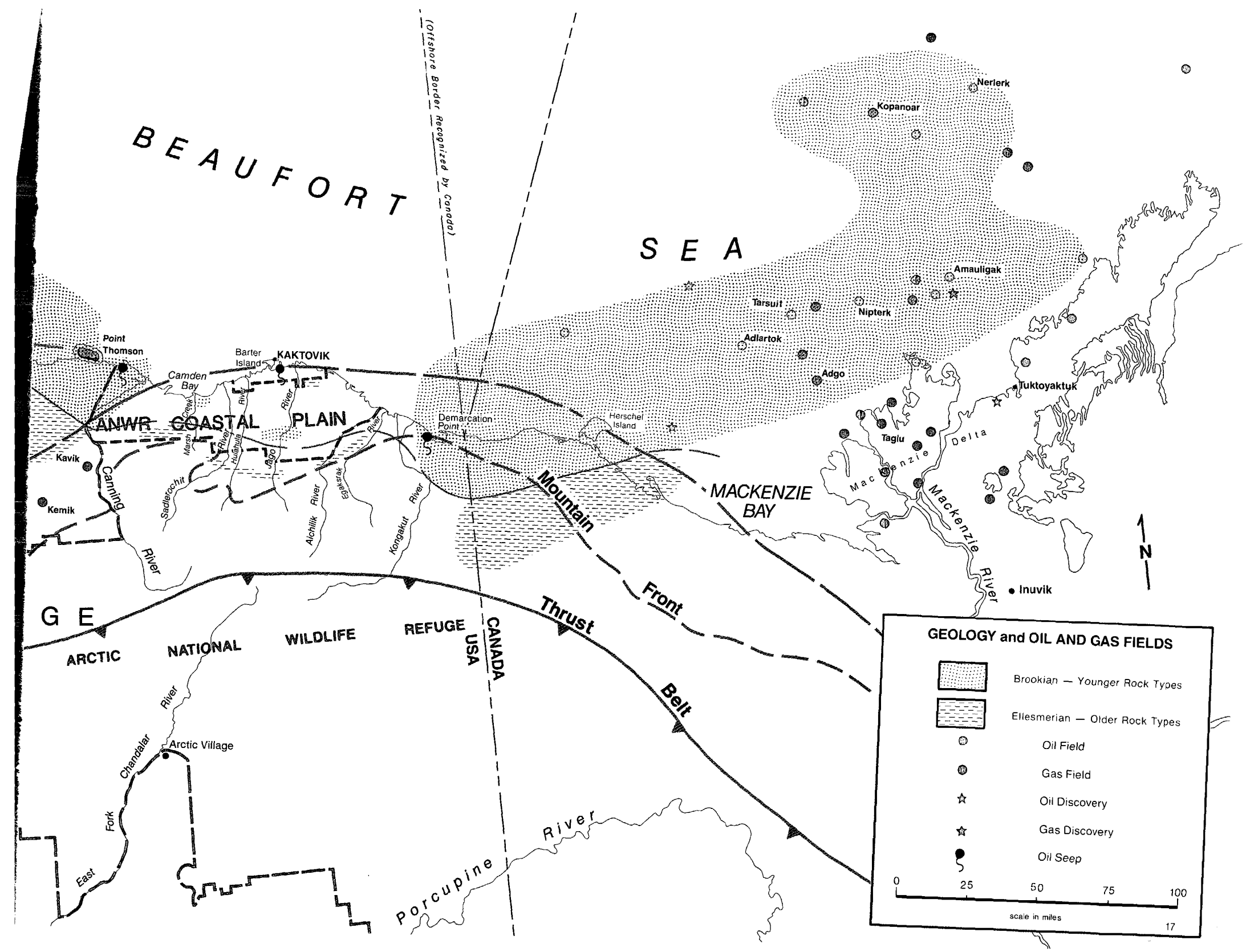
Source: Alaska Department of Revenue, March 1986

U.S. OIL SUPPLY AND DEMAND

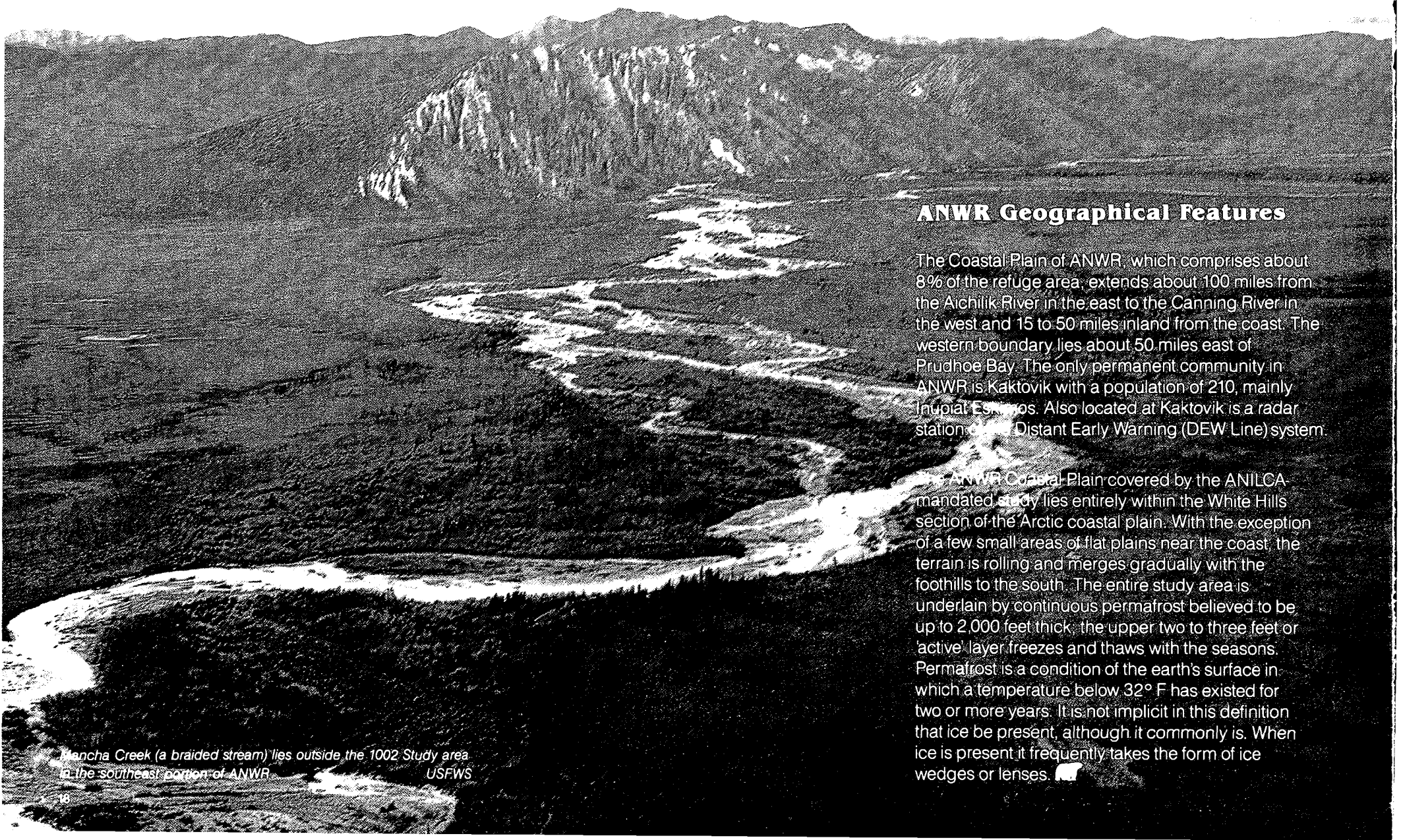


Source: Dames & Moore, 1985; Oil and Gas Journal, March 17, 1986 (adapted from Energy Information Administration)


BARROW
East Barrow
South Barrow
Barrow Arch
Simpson
Meade River
Meade
Harrison Bay
Colville Delta
Milne Point Oil Field
Seal Island
Lisburne
Endicott Oil Field
Fish Creek
Kuparuk Oil Field
Prudhoe Bay Oil Field
Fold Belt Front
Square Lake
White Hills
Colville Trough
Wolf Creek
Umiat
Gubik
East Umiat
COLVILLE RIVER
Thrust Belt
BROOKS RAN
Sagavanirktok River
Noatak River
Kobuk River
16


BEAUFORT
SEA
(Offshore Border Recognized by Canada)
Nerlerk
Kopanoar
Amauligak
Tarsuit
Nipterk
Adlartok
Adgo
Tuktoyaktuk
Point Thomson
Barter Island
KAKTOVIK
Camden Bay
ANWR COASTAL PLAIN
Demarcation Point
Herschel Island
Taglu
Mackenzie Delta
MACKENZIE BAY
Kavik
Kemik
Canning River
Sadlerochit
Marsh Creek
Hulahula River
Jago River
Aichillik River
Egaksrak River
Kongakut River
Mountain Front Thrust Belt
Inuvik
Mackenzie River
N
G E
ARCTIC NATIONAL WILDLIFE REFUGE
USA
CANADA
Arctic Village
Chandalar River
East Fork
Porcupine River
GEOLOGY and OIL AND GAS FIELDS
Brookian — Younger Rock Types
Ellesmerian — Older Rock Types
Oil Field
Gas Field
Oil Discovery
Gas Discovery
Oil Seep
0 25 50 75 100
scale in miles
17

Environment of the ANWR Coastal Plain

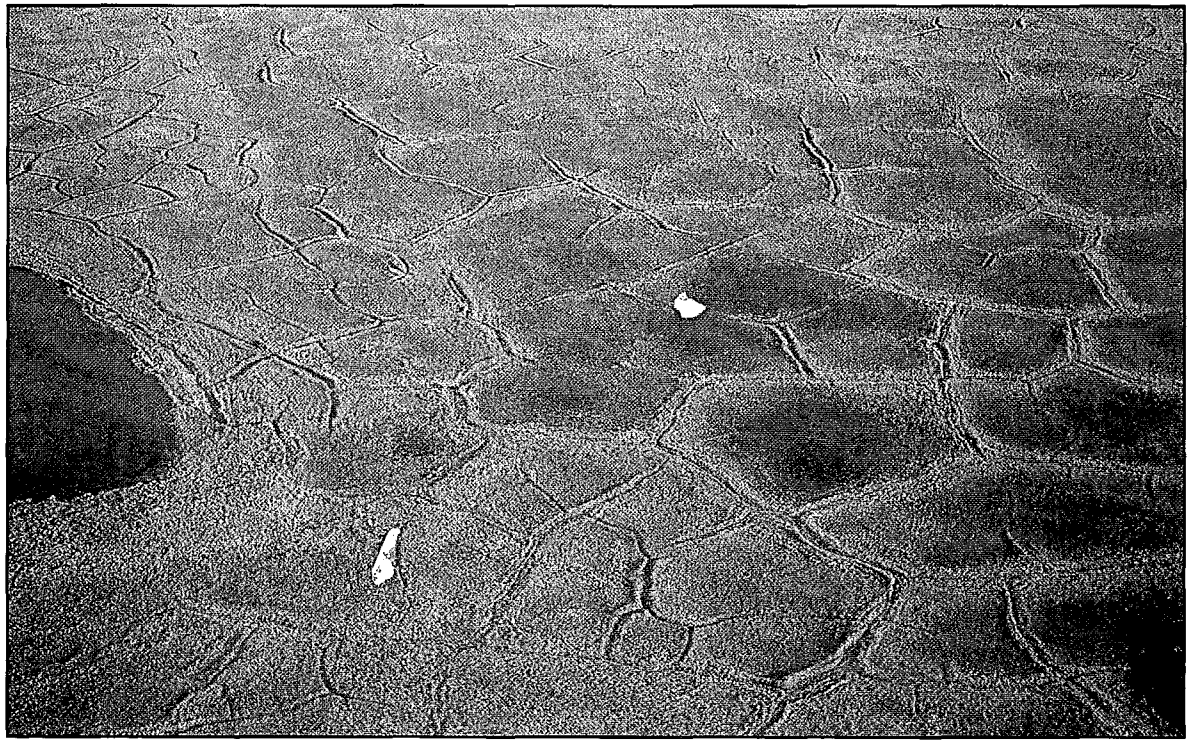


Jancha Creek (a braided stream) lies outside the 1002 Study area in the southeast portion of ANWR. USFWS

ANWR Geographical Features

The Coastal Plain of ANWR, which comprises about 8% of the refuge area, extends about 100 miles from the Aichilik River in the east to the Canning River in the west and 15 to 50 miles inland from the coast. The western boundary lies about 50 miles east of Prudhoe Bay. The only permanent community in ANWR is Kaktovik with a population of 210, mainly Inupiat Eskimos. Also located at Kaktovik is a radar station of the Distant Early Warning (DEW Line) system.

The ANWR Coastal Plain covered by the ANILCA-mandated study lies entirely within the White Hills section of the Arctic coastal plain. With the exception of a few small areas of flat plains near the coast, the terrain is rolling and merges gradually with the foothills to the south. The entire study area is underlain by continuous permafrost believed to be up to 2,000 feet thick, the upper two to three feet or 'active' layer freezes and thaws with the seasons. Permafrost is a condition of the earth's surface in which a temperature below 32° F has existed for two or more years. It is not implicit in this definition that ice be present, although it commonly is. When ice is present it frequently takes the form of ice wedges or lenses.

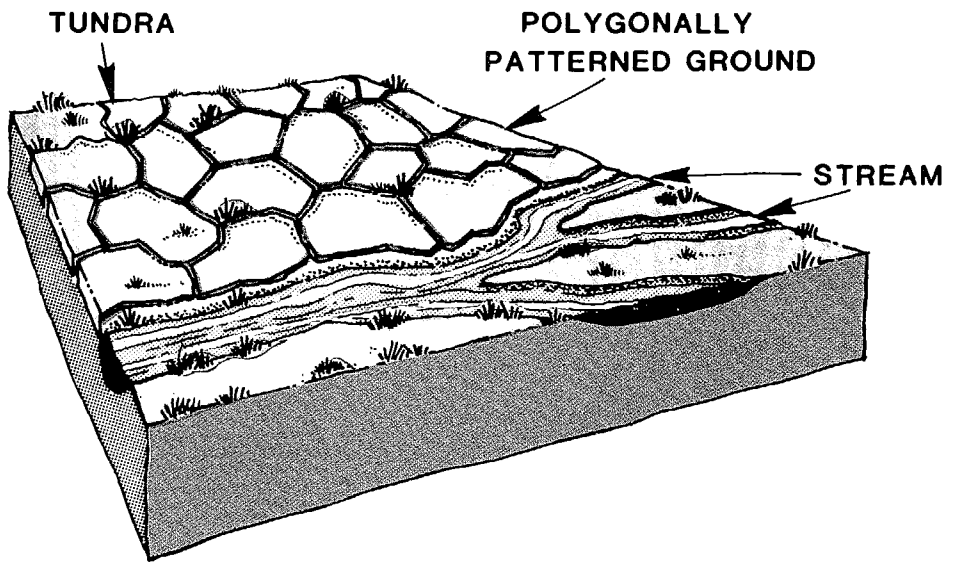


Polygonally patterned ground.

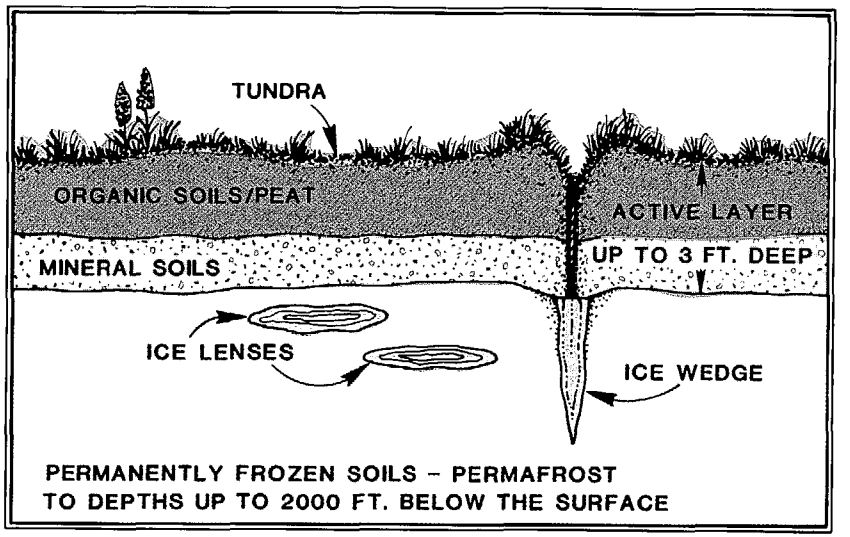
Landforms in ANWR

In many locations, seasonal thawing of the surface has resulted in the formation of polygonally patterned ground. The polygons develop in response to intense winter cooling and subsequent contraction of the fine-grained sediments. The thermal contraction cracks are subsequently filled by ice. The process of freezing and thawing, repeated over many centuries, results in vertical, wedge-shaped masses of ice that penetrate several feet into the soil. The result is a mosaic of polygons on the tundra, ranging up to twenty feet in diameter.

At the surface, the tundra serves to insulate the soils, limiting the depth of thaw during the summer months to no more than two or three feet in most areas. If the tundra is disturbed, deeper seasonal thawing may occur. Once the thermal balance is destroyed, it may take years to stabilize again. During that time, ponds may develop as ice wedges melt and soils subside, altering terrain, changing the vegetative cover, or in extreme cases, resulting in erosion.



Ice wedges in the permafrost outline polygonal patterns on the tundra surface.



Cross section shows active layer and permafrost. The active layer freezes during the winter, thaws in summer. Ice lenses may occur throughout permanently frozen soils. Ice wedges develop in shrinkage cracks.

Biologists study tussock tundra in the 1002 study area. *USFWS*

Marsh Marigolds.

Anemone or windflower.

Cotton Grass. *W. Horstmann*

Vegetation Communities in ANWR

Several tundra vegetation and landform types occur within the region, including thaw lake plains, hilly coastal plains, foothills, and flood plains.

On the tundra, microclimates which are responsible for much of the species diversity in the region are dynamic. The growth of ice wedges causes soils to be pushed upward exposing the vegetation to prevailing winds; the same process deepens the troughs between polygons. Over time, plant species at a particular site will change along with subtle changes in the microclimates.

Thaw Lake Plain. Thaw lake plains, characterized by polygonally patterned ground and shallow pond complexes, occur in less than 3 percent of the ANWR study area. The thaw lake plain extends up to 10 miles inland from the Beaufort Sea coast. This terrain type is similar to that of the main portion of the Prudhoe Bay oil field, consisting of numerous thaw lakes, drained lake basins, and expanses of low-centered ice-wedge polygons. Microtopography in this terrain type has a major influence on the distribution of plant communities.

Vegetation in drained lake basins consists of aquatic and wet tundra species including pendant grass, aquatic sedges, and cottongrass. Species commonly found in wet tundra areas are sedges, cotton grasses, a few herbaceous plants and mosses. These plant communities are considered to be particularly important for nesting birds and are heavily grazed by waterfowl prior to the fall migration. In saline soils, primary species are alkali and scurvy grasses, sedges and chickweed.

Hilly Coastal Plain. Hilly coastal plain terrain contains gently rolling topography and poorly developed ice-wedge polygons. This terrain type is found in 22 percent of the study area. Well drained sites either within the coastal plain or the rolling hills farther inland harbor vegetation which includes sedges, mosses, crustose lichens, and prostrate shrubs.

Species commonly found in these areas are several varieties of willows and herbaceous plants. On small hummocks, communities of avens and sedges occupy sites with mosses and crustose lichens.

Tussock tundra occurs frequently in the relatively well-drained soils of the hilly plain. Vegetation in these areas consists of a high percentage cover of cottongrass with dwarf or prostrate shrubs, including several varieties of willows, dwarf birch, and Labrador tea. Tussock tundra is dynamic; in these vegetation communities, older tussocks age and die. Other plant species then revegetate the site. Scientists have observed that revegetation of areas where tussocks have been damaged by vehicular traffic is similar to revegetation due to natural succession within plant communities.

Foothills. Foothills comprise about 45 percent of the study area and are characterized by hills separated by drainage channels, giving the slopes a decidedly ribbed appearance. Vegetation in the foothills is primarily sedge tussocks and dwarf shrubs. Slopes in the foothills are vegetated mainly by dwarf shrub willow, birch, and alders. The height and density of these plants varies with the amount of protection provided to the shrubs by surrounding slopes. In deep drainages where the plants are protected from scouring winds, willows may reach heights of six feet, compared to the dwarf shrubs of the coastal plain that seldom exceed several inches in height.

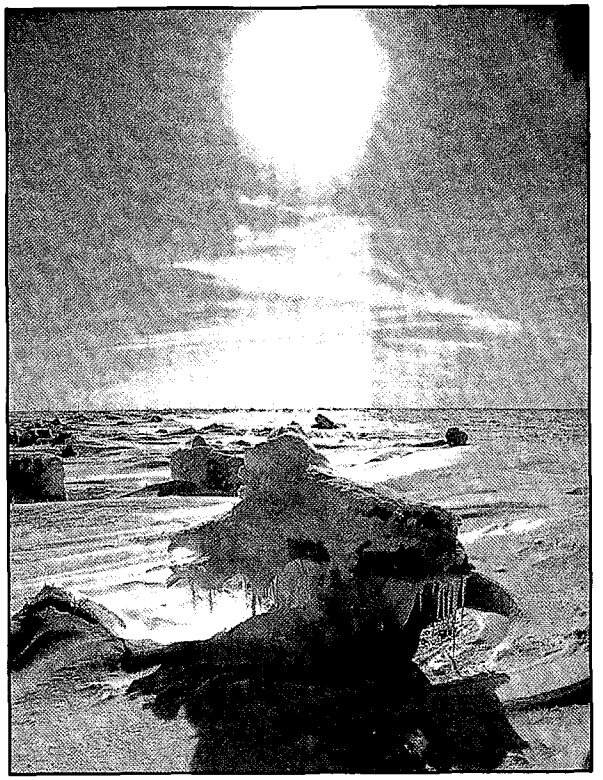
River Flood Plains. River flood plains, which make up about 25 percent of the study area, are typified by barren deltas and braided river channels and the terraces and alluvial deposits associated with old river channels.

The remaining area consists of alpine tundra, occurring at the southern boundary of the study area.

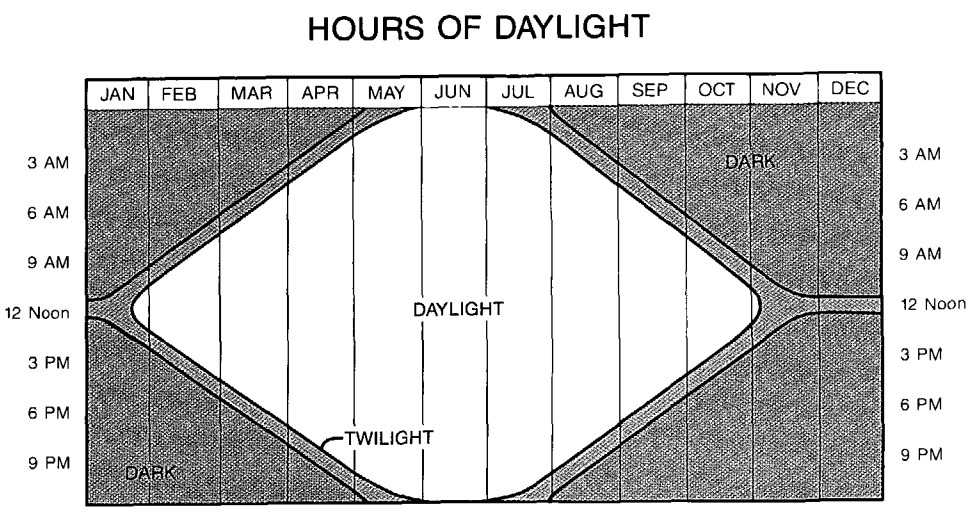
Climate

The study area demonstrates a striking contrast between summer and winter. During the summer months temperatures are relatively warm (40° F.) and daylight is continuous. During the winter months temperatures drop well below 0° F and blowing snow fills in valleys and swales, resulting in the appearance of a vast, white wasteland.

ANWR WEATHER	
Average Summer Temperature (July)	41°F (5°C)
Maximum Summer Temperature	86°F (30°C)
Average Winter Temperature (Feb.)	-4°F (-20°C)
Total Cloud Cover	54% of year
Expected Days of Fog	115 days
Average Annual Rainfall	10 in. (25 cm)
Prevailing Winds at Barter Island	13 knots easterly



Nearly continuous winds reshape the coastal plain winter landscape.



Wildlife in ANWR

Caribou in the Refuge

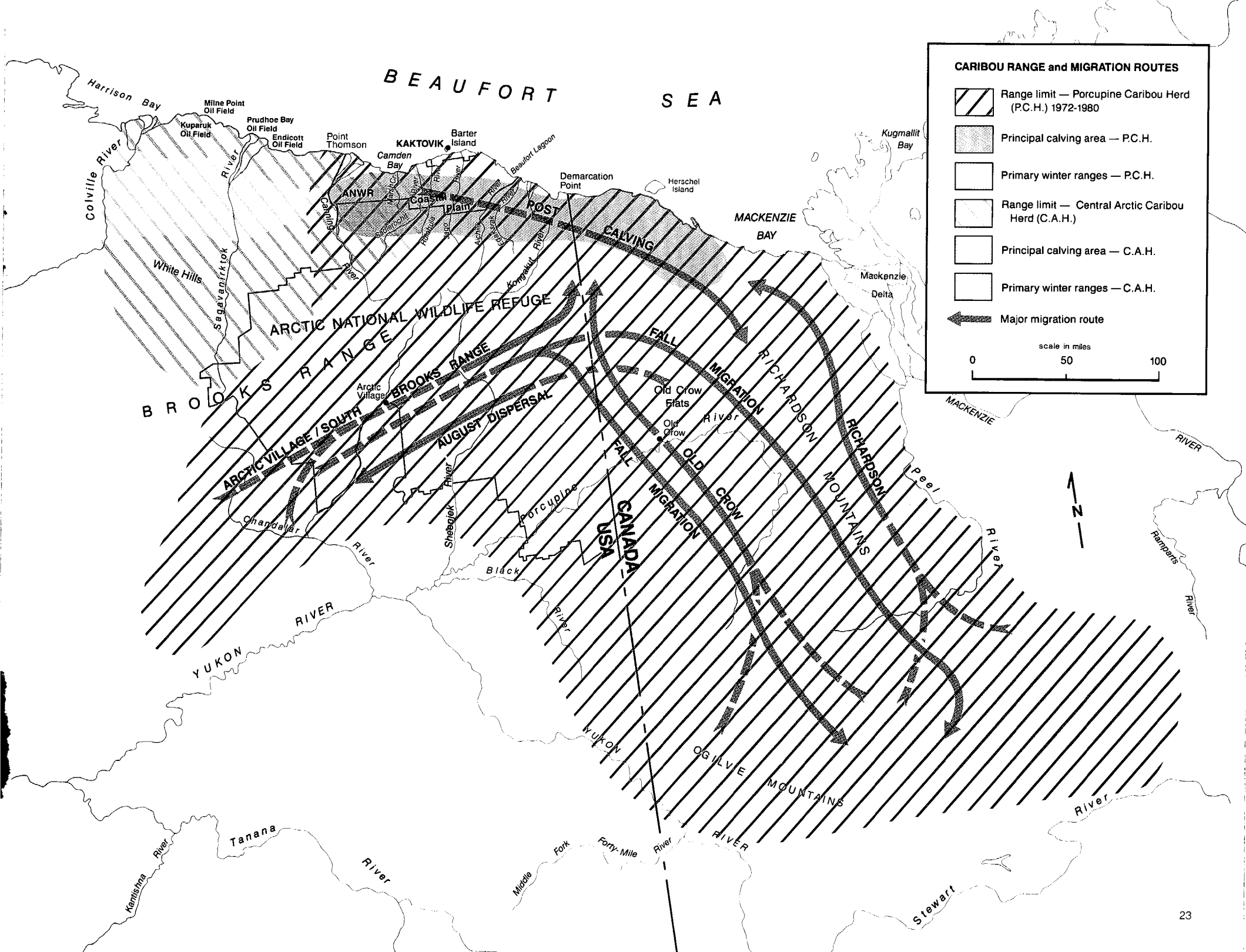
Caribou are the most numerous large mammals in ANWR. Two herds occur there: the Porcupine Herd (named after the Porcupine River) and the Central Arctic Herd. ANWR is within the main range of the Porcupine Herd, which numbers 150,000 to 170,000 animals and on the periphery of the range of the smaller Central Arctic Herd (13,000 animals). The following discussion focuses on the Porcupine Herd, but basic features of the ecology and annual cycle of events are similar for both groups. During the year, caribou go through seven distinct phases of activities, some involving long migrations.

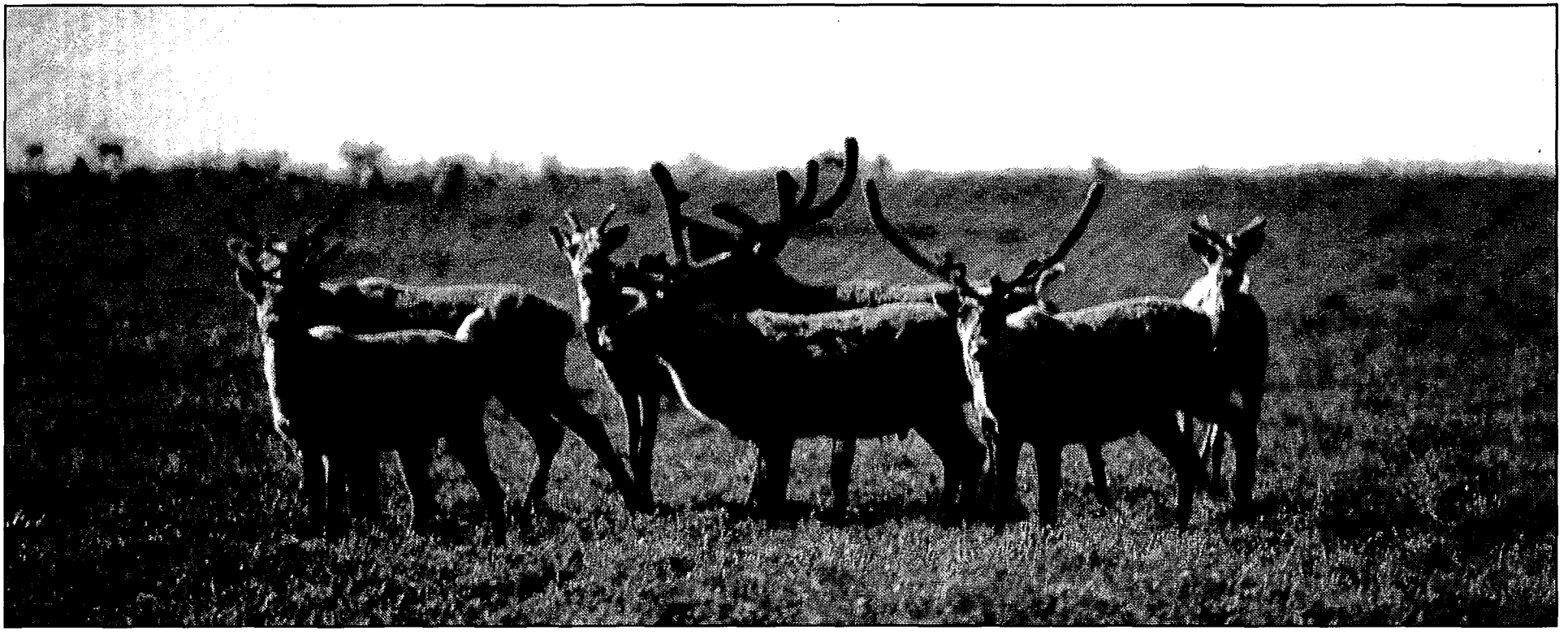
Spring Migration. The spring migration begins in early March as caribou gradually drift toward the northern limits of their wintering areas. The Porcupine Herd follows three major routes to the North Slope from primary wintering areas in Alaska and the Yukon Territories: the Richardson route through the Richardson, Barn, and British Mountains; the Old Crow route, which crosses the Porcupine River near the settlement of Old Crow and continues northward through the Old Crow Flats, over the British Mountains and through the Firth River Valley; and the Arctic Village/South Brooks Range route which crosses the East Fork of the Chandalar River, the Sheenjik, and upper Coleen rivers and follows the Firth River into Canada where it joins the Old Crow route.

The caribou segregate themselves into groups which migrate at different times. Pregnant females along with some yearlings and barren cows are the first to migrate, followed by bulls and the remaining juveniles. In mid-to-late May the pregnant females arrive on the North Slope, while the others follow a few weeks later.

Calving. Calving takes place during the last week in May and first two weeks of June in the foothills and coastal plain between the Hulahula and Babbage rivers, an area that is generally snow free by early June. Caribou are not distributed evenly across the area; instead, they gather in more limited locations which vary from year to year.

Caribou herd during the post-calving aggregation (late June).


CARIBOU RANGE and MIGRATION ROUTES
Range limit — Porcupine Caribou Herd (P.C.H.) 1972-1980
Principal calving area — P.C.H.
Primary winter ranges — P.C.H.
Range limit — Central Arctic Caribou Herd (C.A.H.)
Principal calving area — C.A.H.
Primary winter ranges — C.A.H.
Major migration route
scale in miles
0
50
100
BEAUFORT SEA
Harrison Bay
Milne Point Oil Field
Kuparuk Oil Field
Prudhoe Bay Oil Field
Endicott Oil Field
Point Thomson
KAKTOVIK
Barter Island
Camden Bay
Beaufort Lagoon
Demarcation Point
Herschel Island
Kugmallit Bay
MACKENZIE BAY
Mackenzie Delta
Colville River
ANWR
Coastal Plain
POST CALVING
White Hills
Sagavanirktok River
ARCTIC NATIONAL WILDLIFE REFUGE
BROOKS RANGE
Arctic Village
ARCTIC VILLAGE / SOUTH
AUGUST DISPERSAL
FALL MIGRATION
Old Crow Flats
Old Crow
OLD CROW
RICHARDSON MOUNTAINS
MACKENZIE RIVER
Peel River
Ramparts River
Chandalar River
Sheenjek River
Porcupine River
Black River
CANADA
USA
YUKON RIVER
YUKON
OGILVIE MOUNTAINS
Tanana River
Kantishna River
Middle Fork
Forty-Mile River
Stewart River
N



Caribou rest as the insect harassment season begins (late June).

There is a high degree of synchrony in the timing of the births, and this synchrony is probably an adaptation to reduce predation by 'swamping' the predators — primarily grizzlies, wolves, and occasionally golden eagles. That is, for a brief period, calves are superabundant, far more numerous than the predators can kill. This allows most of the calves to develop to the stage where they are able to escape.

The calves are able to stand and nurse within an hour or two after birth, and within 24 hours they can follow their mothers and even run for short distances. The calves' precociousness is an obvious advantage where cover is sparse and predators common. Many cows with calves assemble to form small nursery bands, and these groups move slowly through the calving grounds, where the cows graze, favoring new-growth cottongrass shoots.

Post-calving Aggregation. As the mosquitoes emerge in late June and early July, the caribou gather into enormous post-calving aggregations, sometimes numbering in the tens of thousands. For example, in 1972, over 80,000 caribou assembled in one group south of Camden Bay. The caribou seek areas where breezes and cooler temperatures reduce the harassment by mosquitoes, and when there is no wind, the caribou move continually. Cold winds offer relief from the mosquitoes and permit the caribou to rest and feed freely.

During this period, the Porcupine caribou travel south and east into Canada. By mid-to-late July, most of the caribou have moved out of the Coastal Plain and into the foothills and mountains. As the mosquitoes decline, the caribou disperse, only to be plagued by two other insect pests — the warble fly and the nose-bot fly.

Dispersal. The warble fly, which looks like a small yellow and black bumble bee, lays its eggs in the fur of the legs or abdomen of the caribou. The larvae soon hatch, burrow under the skin, and travel to the back. Here they encapsulate and cut a breathing hole in the skin. Caribou commonly carry over one hundred larvae. It is not until May and June of the following year that the larvae cut exit holes, crawl out and drop to the ground to develop into mature flies.

The nose bot bears live larvae, which it deposits in the nostrils of the caribou. The bot larvae move through the nasal passages and settle down at the entrance to the throat. By spring the larvae have grown so much that they may form a mass large enough to actually interfere with breathing.

The reaction of the caribou to these flies is different from the reaction to mosquitoes. The warble and

nose bot flies are strong fliers and the caribou cannot avoid them simply by seeking breezy places or moving into the wind. Instead the caribou stand, heads held low, alert for the approach of the flies. During July and early August, caribou can be seen violently shaking their heads, stamping their feet, and racing wildly over the tundra, for no apparent reason: they are seeking to evade warble or bot flies. The fly season is followed by a month's respite when the caribou can feed unmolested.

Fall Migration. The fall migration begins by the second week of September as the caribou start to move generally southward. This migration will carry the caribou one hundred to three hundred miles south into the area south of the Brooks Range, in the vicinity of Arctic Village, Alaska, and into the southern Richardson and Ogilvie mountains in the Yukon Territory. The caribou continue to lay on fat as they move south; the males will need the energy reserves for the rut and all will need it during the winter. At this time, the bulls are shedding the velvet from their antlers and rubbing them against trees and shrubs. The bulls are also becoming increasingly more aggressive, engaging in brief sparring matches.

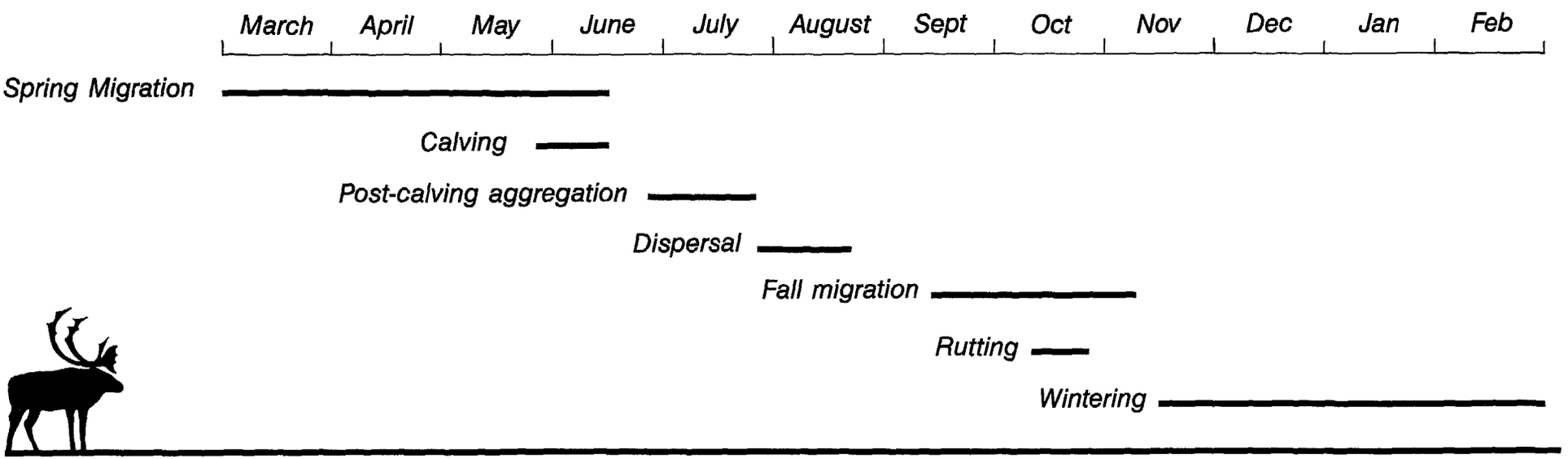
Rutting. The rut lasts for a two-week period in mid-October. During this time the bulls fast, relying on their reserves of body fat. This brief breeding period helps to explain why the calving season is similarly brief. Even during the rut, the animals continue on to their winter ranges.

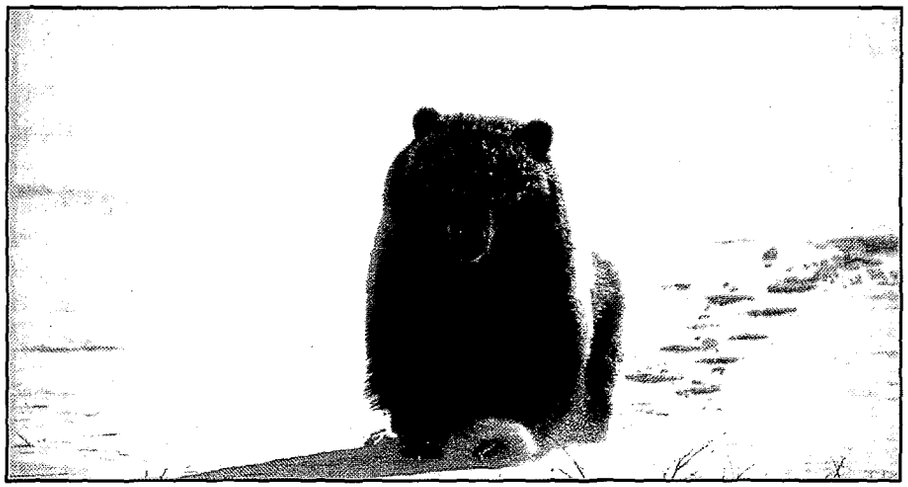
Wintering. Winter is a difficult period for the caribou. Food plants are often covered by snow, so that the caribou have to dig to gain access; nor are the food plants in the winter as nutritious or as easily digested as are those available in summer. Over the winter the animals usually lose weight.

Central Arctic Herd. The other caribou in ANWR, the Central Arctic Herd, follow the same basic pattern as that followed by the Porcupine Herd. However, in most years some individuals, several hundred to a thousand, spend the winter on the Coastal Plain within the northwestern part of ANWR.

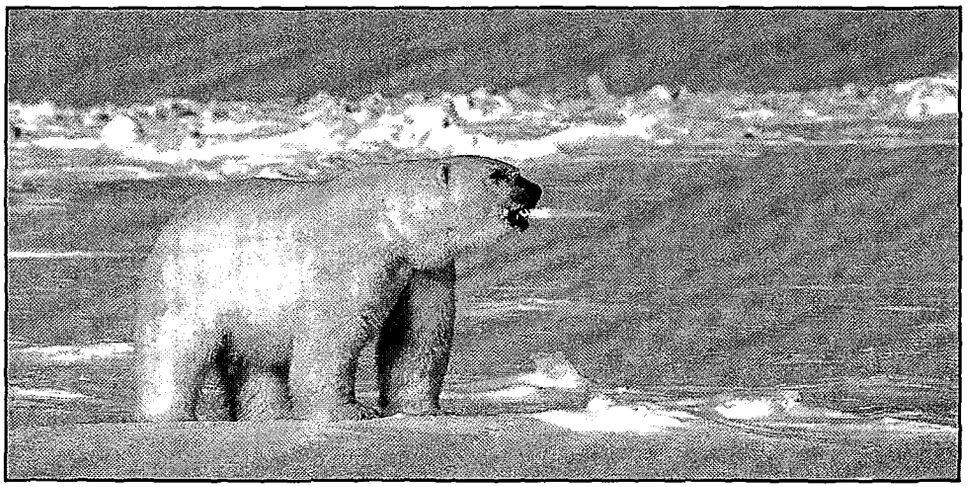
Caribou Populations. Both the Porcupine and Central Arctic herds are biologically healthy. The Porcupine Herd has been growing steadily and is estimated to contain 150,000 to 170,000 animals. The Central Arctic Herd has been growing at a rate of 12 to 18 percent per year. It was estimated to be made up of about 3,000 animals in 1972, but now numbers over 13,000, a four-fold increase in 13 years.

ANNUAL CYCLE OF EVENTS OF CARIBOU





Grizzly Bear.



Polar Bear. *S. Amstrup*

Other Mammals in ANWR

Grizzly Bears. Grizzly bears enter their dens sometime during the first two weeks of October and remain there until mid-April in the case of most adults or mid-May in the case of sows with new born cubs. The bears spend about half of the year avoiding the environmentally stressful winter period. Within ANWR, most dens are located on southfacing slopes in the mountains south of the Coastal Plain, where prevailing winds favor the accumulation of an insulating layer of snow. In contrast with den sites in more southerly areas, bear dens in ANWR are not surrounded by shrubby vegetation with roots that stabilize the soil. Because the soils tend to be coarse textured and poorly bonded, dens cannot be dug until the ground has frozen to a depth of about four inches. Dens in ANWR usually collapse with the spring thaw and cannot be reused in subsequent years.

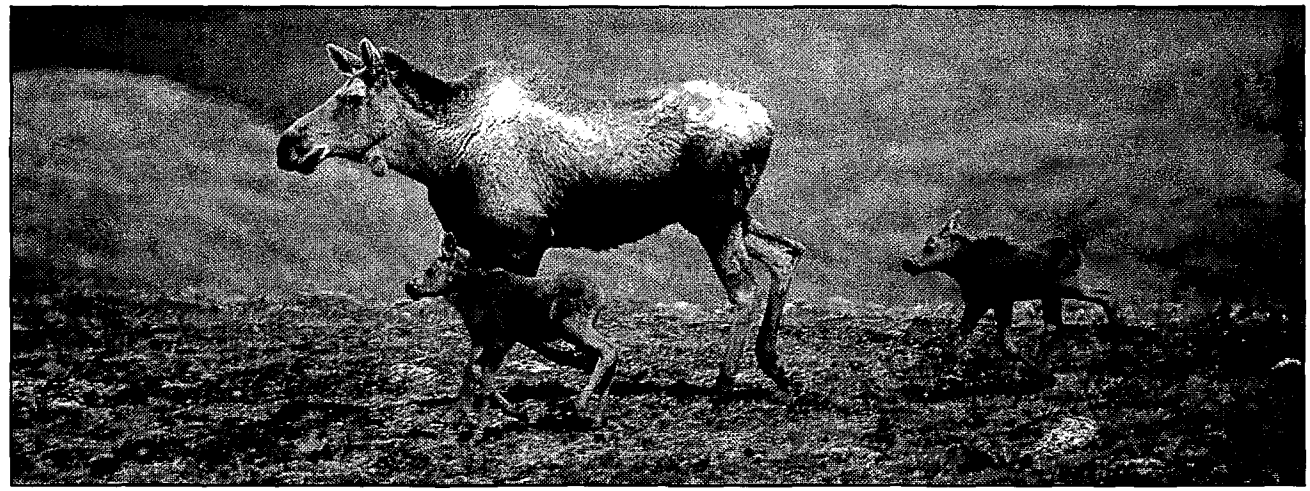
Grizzlies are opportunistic feeders, feeding on carrion, vegetation, and berries, or preying on other animals such as caribou, moose, and ground squirrels. In the period immediately after the bears have emerged from their dens, they forage along river drainages. During the summer, grizzlies associate with caribou herds, feeding on carrion and preying on both adults and calves, as well as feeding on horsetail and other vegetation. During August and September, the bears return to river valleys and gradually make their way upstream to denning areas. At this time they tend to feed on berries and ground squirrels which they dig from their burrows.

In the northern areas, probably due to the short time each year when the bears are active, their growth and development are protracted over a longer period than in the more southerly areas. That is, females do not produce young until they are 6 to 12 years of age and cubs remain with their mothers for up to five years. The average litter size is 1.6 to 1.8, which is somewhat smaller than is generally found in more southerly areas. Natural mortality is generally low among grizzly bears, except for cubs. About one-half of all cubs are killed by adult male bears.

Polar Bears. Throughout most of the year, polar bears are closely associated with the ice of the Beaufort Sea offshore of the coastal plain. The sea ice is the habitat of the ringed seal, which makes up over 90 percent of the polar bear's diet. Polar bears also feed on bearded seals, which are not common in the Beaufort, and even on walrus and beluga whales. In the fall, as freeze-up proceeds, some bears move to the coast to scavenge beach-cast carrion and the remains of bowhead whales taken by whalers from Kaktovik.

Pregnant females dig their maternal dens on the mainland, on islands, or on the sea ice. In all of these locations, the bears seek areas where there is a large accumulation of drifted snow. They excavate dens during October and November, and give birth to one to three cubs in December or January. The cubs weigh little more than a pound at birth and measure about 10 inches long. By the time they emerge from the den in March or April, the cubs have grown to between 25 and 35 pounds. The sow and cubs remain close to the den for one or two weeks after emergence, during which time the cubs gain strength and become accustomed to the colder

Muskox in ANWR. *M. Robus*



Moose with calves. *D. Schmidt*

temperatures outside the den. At this point, those bears that denned on land move out onto the sea ice. The sows and cubs range over the sea ice to hunt for food. The cubs may remain with their mothers for up to 28 months.

For many years biologists believed that nearly all maternal dens were located on land. Although this may be true in certain areas, researchers have discovered that nearly 90 percent of the maternal dens in the northern Alaska region are on the sea ice.

Polar bears are protected under the terms of the Marine Mammal Protection Act. Although sport hunting is no longer permitted, hunting by Alaskan Natives is unrestricted.

Wolves. Wolves are widely distributed throughout Alaska and much of Canada. They are the largest wild members of the dog family, and adult males often weigh more than 100 pounds. They have a highly developed social structure which is manifested in the pack which is made up largely of family members. Within the pack, breeding is confined to the dominant male and the dominant female. Breeding takes place in late winter, and the pups are born during mid-May to early June, just before the time when the caribou are giving birth to their calves. The pups remain in the dens for three weeks before they begin to spend time outside, near the den. They usually remain at the den until sometime in July.

Wolves obtain most of their food by preying on large ungulates (caribou, Dall sheep, moose), particularly caribou. In some instances it is thought that wolf predation, particularly on calves, has been sufficient to cause caribou populations to decline. (Part of the explanation for the rapid growth of the Central Arctic Herd of caribou may be the virtual absence of wolves.)

Muskoxen. With their squat silhouette and shaggy pelage, muskoxen look like a relic from the Ice Age. Their habit of forming a defensive circle in the face of danger resulted in near extinction of the species by hunters with guns; the animal's instinctive defense mechanism protects them from wolves, but not from bullets. Muskoxen formerly were found throughout arctic Alaska, but they were wiped out after firearms were introduced into ANWR during the mid-1800s. In 1930, the U.S. Fish and Wildlife Service purchased 34 muskoxen from Greenland and transported them to Nunivak Island just off the west coast of Alaska in the Bering Sea. The animals prospered there in the absence of predators or competitors for forage. In 1969 and 1970, muskoxen were transplanted into ANWR. Since that time they have established themselves and the population has grown rapidly. In 1972, there were about 40 muskoxen in ANWR; in 1985 there were nearly 400, divided among three herds.

Muskoxen appear to prefer areas along rivers, where their most favored food, willows, is most abundant. They also feed on sedges and herbaceous plants.

Moose. Although moose are commonly associated with the boreal forests, they range as far north as the Beaufort Sea, making them one of the most widely distributed large mammals in Alaska. Willow is a preferred food plant, and consequently moose are most common along the major river systems where willows are abundant. However, moose are rare in the foothills and coastal plain of ANWR.

Semipalmated Sandpiper nest.

Birds in the Refuge

During the brief arctic summer, the North Slope is home to millions of birds. Many come to nest and raise their young. Others come to molt or simply to pass through on migration. A few species are present year-round.

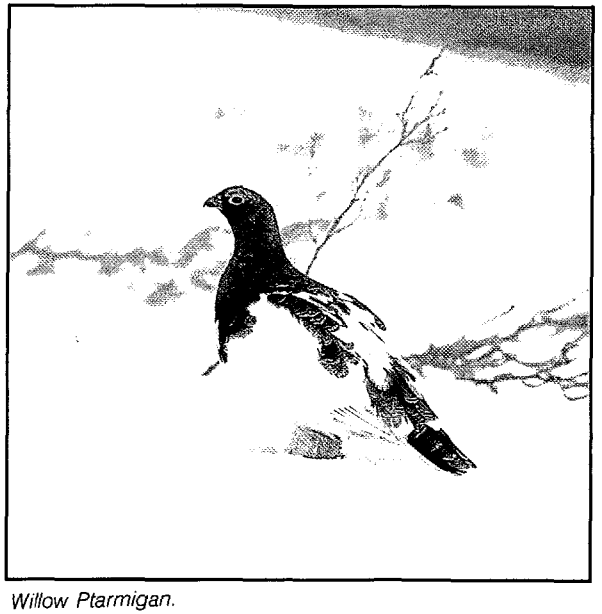
Rock and Willow Ptarmigan are the most abundant birds during winter and are found in patches of willows where they feed mainly on the buds. Ravens are the most conspicuous winter birds. A few Gyrfalcons and Snowy Owls may also be present, depending on the abundance of prey.

Late May and early June bring long days, warmer temperatures, and flocks of migrating birds — ducks, geese, shore birds, jaegers, gulls, terns, songbirds, and others. Some of these stay in ANWR, while others continue to destinations elsewhere in Alaska and Canada. Those that do stop congregate wherever bare ground or open water may be found. River deltas, flooded by meltwater, and shallow ponds are heavily used at this time, as are patches of snow-free tundra. As spring progresses, the birds disperse to occupy suitable habitats.

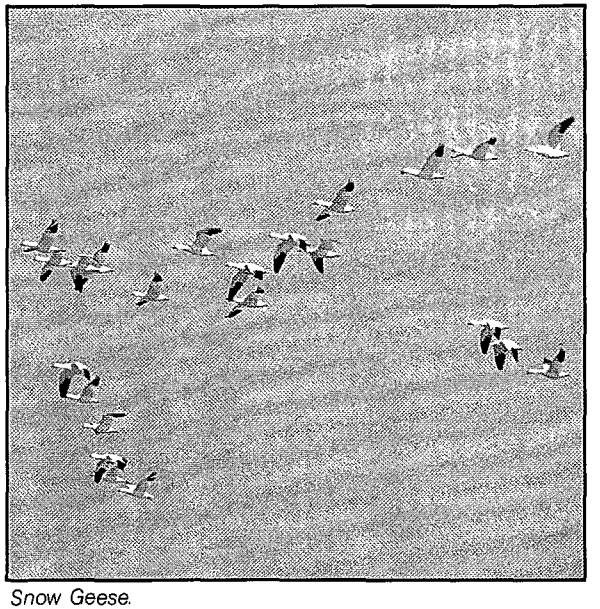
The migratory birds have come great distances from the far reaches of the globe. Dunlins have wintered along the coast of China, Yellow Wagtails and Northern Wheatears in southern Asia and Africa, and Arctic Terns in the Antarctic. Buff-breasted Sandpipers have come from the pampas of Argentina, Red Phalaropes from off the coast of Chile, and Tundra Swans from the Chesapeake Bay area.

Brant use the coastal plain primarily as a migration corridor, resting and feeding on vegetated mudflats while enroute to their main breeding grounds in Canada. Snow Geese feed and rest in wet sedge meadows during their migration to colonial nesting grounds on Banks Island and at the mouth of the Anderson River in Canada.

Almost immediately upon arrival, the birds begin to establish territories and attract mates. By late June most birds are on their nests and incubating eggs, and bird activity on the tundra is less evident. Part of the decline in apparent activity is due to the effort of incubating birds to be inconspicuous, but in addition, many birds actually do leave. In several species, only one parent, usually the female, incubates the eggs



Willow Ptarmigan.



Snow Geese.

and cares for the chicks. For example, while female ducks incubate their eggs, the males migrate to communal molting areas. In contrast to the usual pattern, male phalaropes tend the nest and chicks while the females migrate to wintering areas soon after egg-laying.

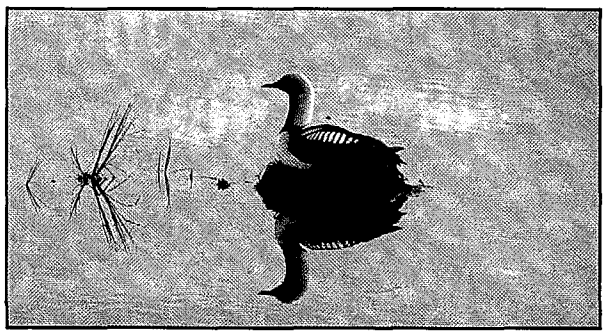
A variety of birds nest in the mosaic of habitats provided by the tundra. Red Phalarope, Northern Phalarope, Pectoral Sandpiper, Semipalmated Sandpiper, Buff-breasted Sandpiper, Dunlin, Lapland Longspur, and Savannah Sparrow are small species that nest in the area. Several species of waterfowl nest in wetlands. Tundra Swan, Canada Goose, Pintail, Oldsquaw, Common Eider, King Eider, and Spectacled Eider all are relatively common. Arctic and Red-throated loons breed on small lakes, as do Sabine's Gulls and Arctic Terns.

Most of the eggs have hatched by mid-July, and the majority of young birds are able to fly and are independent of their parents by the end of July. Waterfowl are the exception. Most young ducks and geese are unable to fly until sometime in August, although they must fledge before the onset of freeze-up.

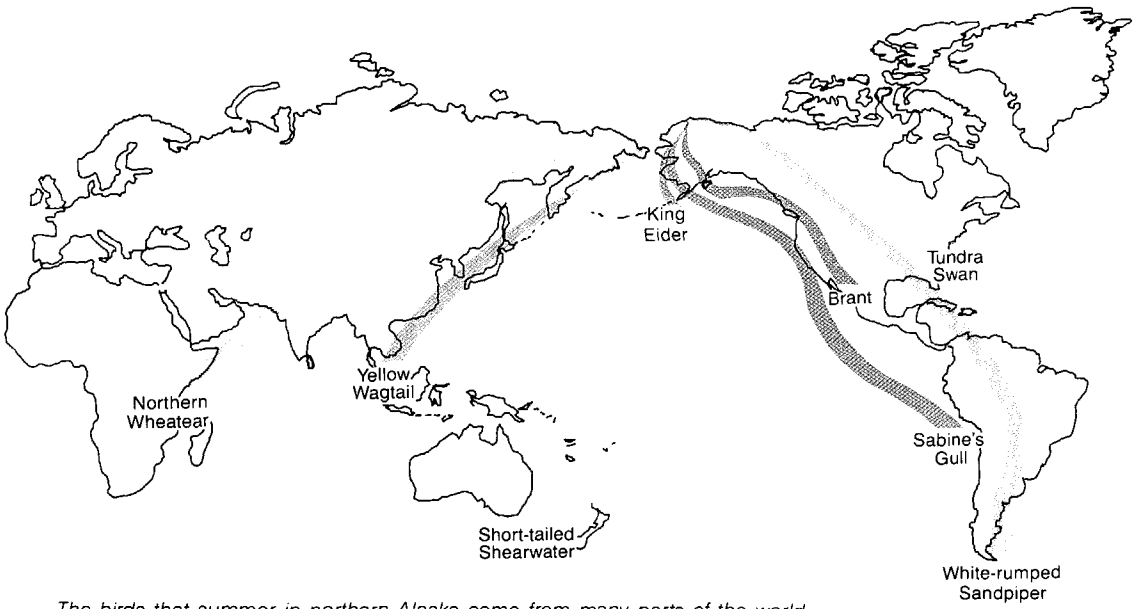
During molt, birds shed old feathers and replace them with new ones. All birds molt at least once each year, and some two or three times. Ducks, geese, swans, and some other groups of birds loose all of their flight feathers at once, rendering them flightless and vulnerable to predators. In addition, the molt is metabolically stressful owing to the demands for growing new feathers. Thus, in advance of this molt, waterfowl move to areas where food is abundant and they are safe from predation. For example, oldsquaw move to sheltered lagoons along the Beaufort Sea coast. There they feed in the protected waters and rest on the beaches of the islands that usually are free of mammalian predators, such as foxes.

By mid-August most waterfowl are again able to fly. Some species, such as Canada Geese, Brant, and Snow Geese, congregate in coastal areas and graze on vegetation in saline and brackish meadows, laying on fat for energy to carry them south on the fall migration. In late August and early September, numerous flocks of waterfowl migrate along the coast or over the tundra. Waterfowl leave northern Alaska by several routes. Brant fly west along the Beaufort coast and then southward, ultimately ending up in Baja California. Snow Geese and Greater White-fronted Geese fly eastward to the Mackenzie River Valley and then turn southward toward destinations in the southern United States and Mexico.

By the time the tundra and Beaufort Sea freeze over and become snow covered, most of the birds have left northern Alaska and the tundra becomes quiet again until the next spring.

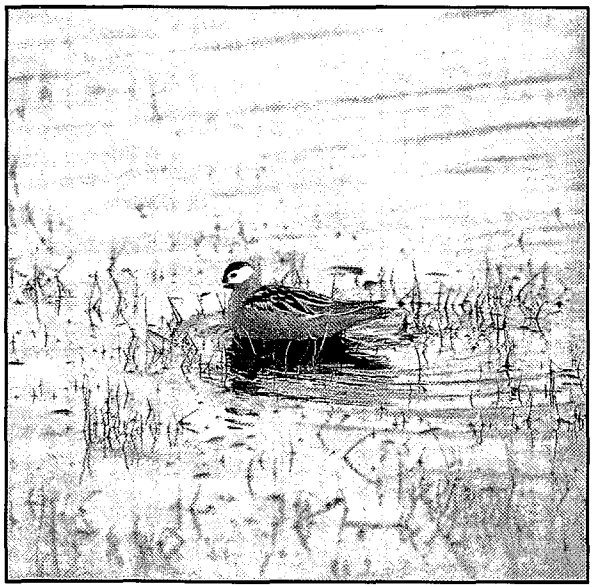


Arctic Loon on nest. *D. Herter*



The birds that summer in northern Alaska come from many parts of the world.

Tundra Swans.



Red Phalarope.

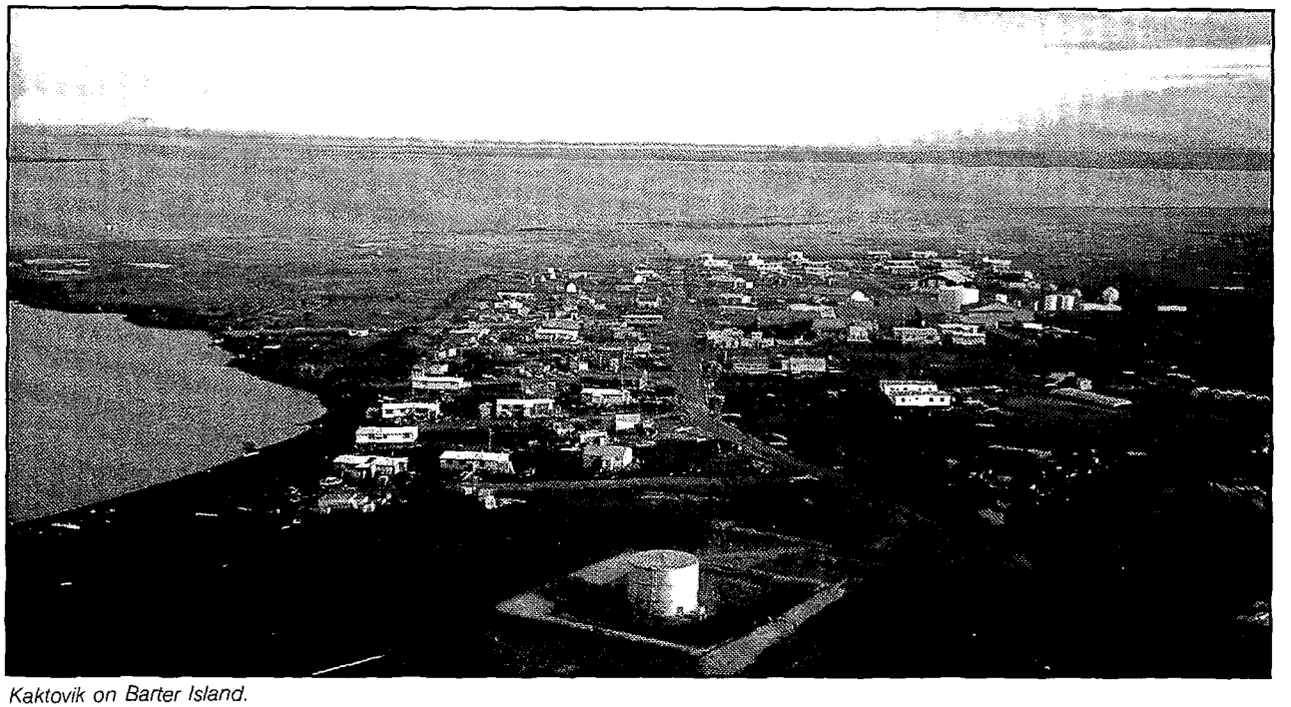
People in ANWR

History

Kaktovik, located just north of the ANWR Coastal Plain on Barter Island, is the only village within the Refuge. Barter Island was an important stop for commercial whalers during the 1890s and early 1900s, but it was not until 1923 that there was a permanent settlement there. In that year, Tom Gordon established a fur trading post for the H.B. Liebes Company of San Francisco. The trading post served as an exchange point for furs and was the beginning of Kaktovik as a permanent settlement. During the years that followed, residents of the region were semi-nomadic, moving from place to place depending on the availability of fish, fur, game, and marine mammals. Today, Kaktovik has approximately 210 residents, most of whom are Inupiat Eskimos whose families have lived in the region for centuries.

Archeological investigations reveal that man has occupied the region for at least 11,000 years. Evidence of man's early presence in the area is sparse, limited to a few archeological sites near the coast. These sites contain artifacts that reflect a hunter-gatherer subsistence economy.

Contact with whalers and traders resulted in replacement of stone and bone implements with knives, axes, and other metal implements. Firearms replaced the bow and arrow and spear. By virtue of their numbers and the fact that many overwintered in the Arctic, the whalers had a profound influence on the culture. The whalers brought trade goods, including food, utensils, firearms, and alcohol, which they exchanged for caribou and sheep meat and for winter clothing manufactured from caribou hides.



Kaktovik on Barter Island.

Stefansson, who explored the region in the early 1900s, noted that although the Inupiat at first had little to do with foods brought in by whalers, they quickly learned to use flour, molasses, and other staples. These foodstuffs first were luxuries and then became necessities.

During the 1890s and early 1900s, Barter Island was a key trading point, and residents of the region came to rely on the ability to obtain trade goods there. With the cessation of whaling for bowheads, in about 1910, the Inupiat experienced the first of a series of boom and bust cycles.

In the 1890s, semi-domesticated reindeer (same species as caribou) were brought to western Alaska from Siberia in order to establish an industry that would provide a more stable economy and would insure against food shortages. In the early 1920s, under the auspices of the Alaska Reindeer Service local superintendent at Barrow, several herds of reindeer were established in the ANWR area. Herders followed their reindeer from the foothills in the winter months to grazing lands near the Beaufort Sea coast during the summer, returning each fall to the foothills. Severe winters during 1936 and 1937 resulted in loss of most of the deer to starvation. Others were killed by people for food and clothing. A Bureau of Indian Affairs survey taken during the spring of 1936 indicated that local residents were destitute and near starvation. In an effort to reestablish the reindeer herds and insure against further food shortages a herd of 3000 reindeer was driven from Barrow to the Barter Island area in late 1937. As the herd approached Barter Island it turned back toward its home range in Barrow, taking most of the remaining local reindeer with it. The people were so discouraged that they killed the few animals that remained, ending the era of reindeer herding in ANWR.

Beginning in the 1920s fur trapping was a good source of cash income, replacing caribou as a trade good. But the price of fox fur dropped in the late 1930s, and trading posts along the coast closed one by one. The post at Barter Island closed following Gordon's death in 1938. By 1943 all of the trading posts in the region had been closed and people had to go to Canada to trade. Eventually, several families moved to Canada. Hard times continued in the region until 1945 when the U.S. Coast and Geodetic Survey began mapping the Beaufort Sea coastline, bringing some wage employment.

Although World War II had little effect on the region, the installation of the Distant Early Warning (DEW Line) system on the island during the 1940s displaced many local residents. In 1947 the U. S. Air Force constructed a runway and hangar on the historic village site, forcing residents to relocate. In 1951, the entire area around Kaktovik was made a military reserve, and some people were required to move again. The village was moved once more in 1964, but this time, residents received title to their village site. Jobs resulting from government activities in the region and the subsequent establishment of a school caused the Barter Island population to increase from less than 50 people in 1950 to approximately 150 in 1953 when several families returned from Canada.

Cash and Subsistence Economies

The changes in living patterns in Kaktovik have been primarily the result of changes in the economy. Traditionally, Inupiat have had a subsistence economy, in which small bands of people harvested plants and animals for food and for raw materials. Typically, all members of the band shared in the system, and in this respect the Inupiat culture was communal. Contact with Western Civilization, however, changed the nature of the Inupiat economic system.

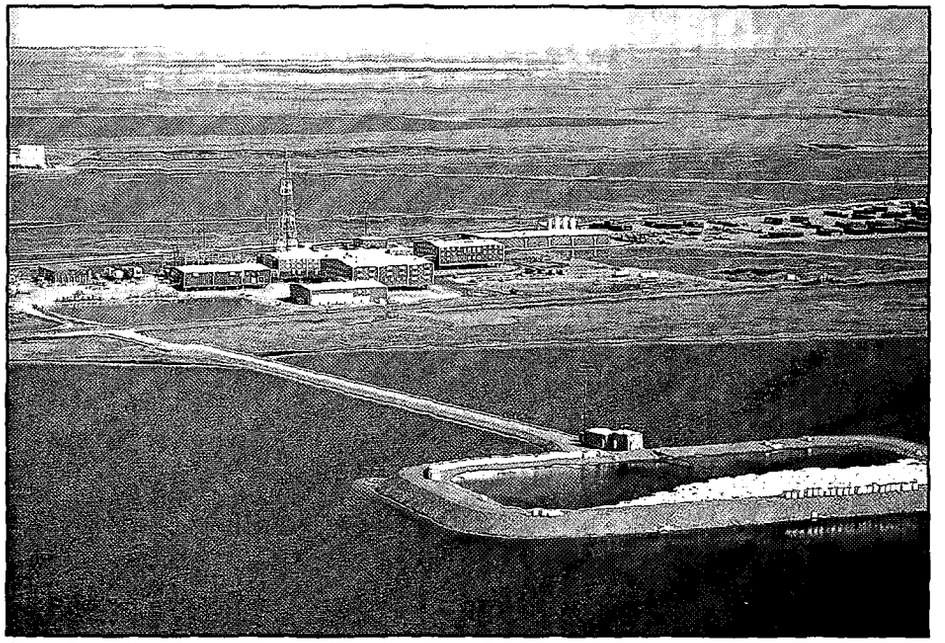
Four distinct waves of economic activity have passed through the region between 1890 and 1975--whaling, trapping, reindeer herding, postwar construction. More recently, oil and gas development and the North Slope Borough capital improvement program have increased economic activity. Throughout these changes, the Inupiat have retained strong ties to the land. The people have continuing links to their natural surroundings, not only to provide food and the raw materials for clothing, tools, and other items, but also to set the defining patterns of their culture—seasonally, socially, and ceremonially. Despite an ability to adopt and incorporate many elements of Western culture, technology, and economy into their lifestyle, the great majority of Inupiat still participate in subsistence activities as hunters and as sponsors and sharers of the hunt. North Slope residents have made it very clear that this is both necessary and preferred for economic, social, and cultural reasons.

For most Inupiat, life without native foods is unthinkable. Native people believe that without traditional ties to nature, the Inupiat social and economic patterns would have no basis. The use of wildlife for subsistence makes it necessary for the Natives to live in small villages. The area around larger villages may become overhunted, forcing residents to range farther and farther in search of wildlife and other subsistence resources.

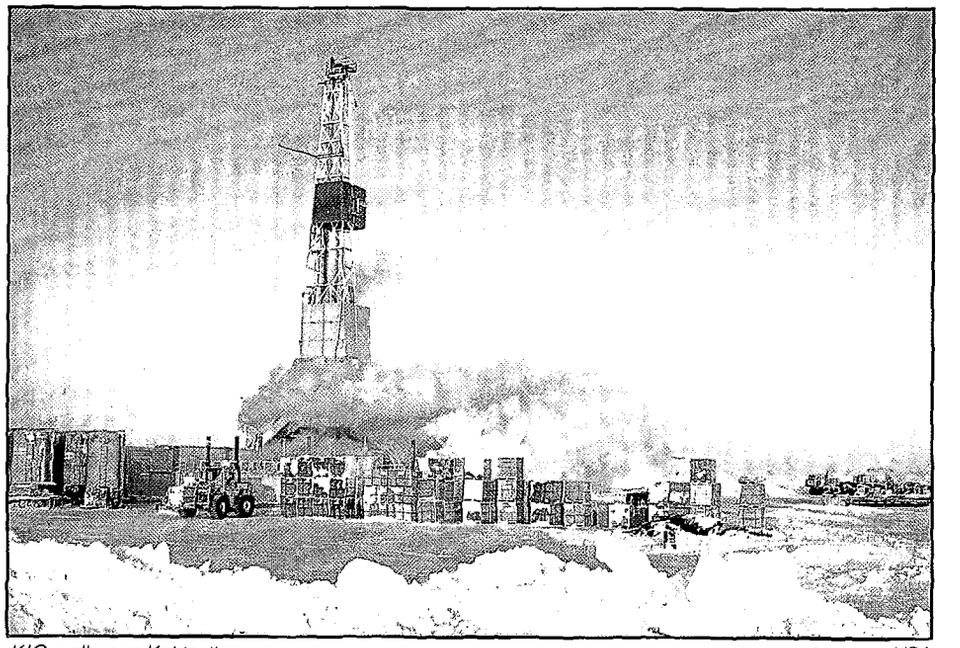
Preservation of subsistence resources and access to them has been identified as a high priority of North Slope residents. A 1977 survey indicated that about eighty percent of Eskimo households on the North Slope obtained at least some of their food through personal hunting and fishing. Forty percent indicated that they got half or more of their total household food through hunting and fishing. Sharing of subsistence resources is especially important; 75 percent reported they had obtained some wild game and fish from other households. Well over 90 percent of the Inupiat residents regularly consume wild foods, regardless of their source.

Kaktovik residents use Dall sheep, caribou, fish, seals, whales, birds and eggs, moose, and furbearers. The relative importance of each resource and the intensity of hunting or gathering at particular sites varies significantly from year to year. Whaling is particularly important. Kaktovik residents hunt bowhead whales, near the village each fall, mainly during September and October.

> *Earning and spending patterns . . . are at least in part culturally determined . . . In any society, a person will work only up to the point at which the costs of working, in terms of time given up, equal the benefits. When the costs of giving up this time begin to exceed the benefits, measured in money, the person quits working. For the Inupiat, this point is often reached earlier than in the non-Native society, because the value to them of what they could buy with that extra money is not worth giving up the extra time.*
>
> Michael J. Jacobson and Cynthia Wentworth in *Kaktovik Subsistence: Land Use Values Through Time in the Arctic National Wildlife Refuge Area.*



Base Operations Center, Western Operating Area, Prudhoe Bay Field. *Standard Alaska*



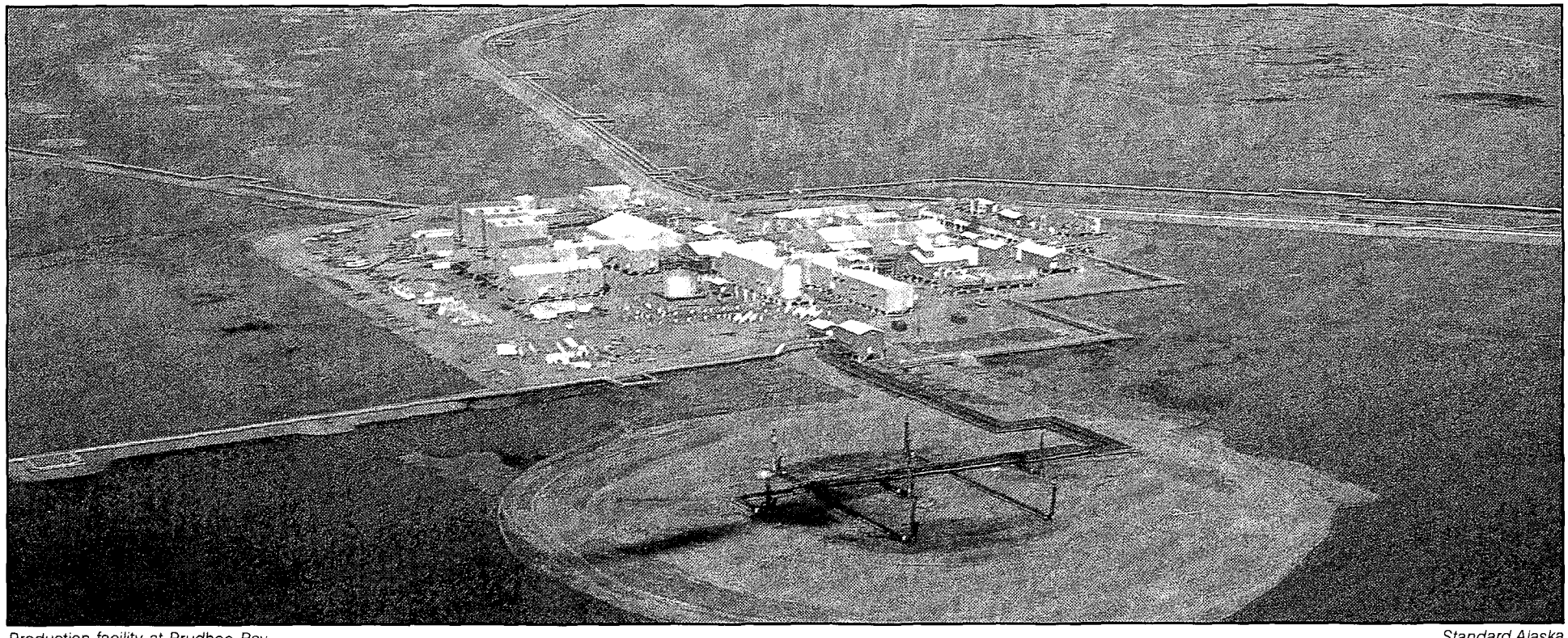
KIC well near Kaktovik. *Chevron USA*

Interaction of the Oil Industry and the Arctic Environment

The petroleum industry has operated in Arctic Alaska for over 40 years. Associated with its operations, there have been many research projects to study the effects of such activity on vegetation and terrain, on waterfowl and other birds, and on mammals, such as caribou. Some of this research has been funded by government agencies, but most of it has been funded by the petroleum industry and conducted by independent scientists. This research has yielded the knowledge that enables the oil industry to explore and develop petroleum resources in the Arctic with a minimum of environmental impact.

The focus of research concerning potential oil and gas development in the ANWR Coastal Plain relates to the effects of development on the area's wildlife, and the tundra vegetation and water resources that provide habitat for those animals. In particular, research has focused on the potential effects on the caribou herds that seasonally use the refuge, and tundra disturbances. To analyze these issues requires a knowledge of wildlife in ANWR and information on their interactions with oil activities elsewhere. It also requires an understanding of exploration and development activities, their timing, and the regulatory framework relating to environmental protection. Throughout all aspects of exploration in Alaska, Federal, State, and local regulatory agencies require permits that ensure adverse environmental effects are kept to minimum. These permits are needed for most petroleum operations including siting of facilities, placement of gravel, routing of temporary and permanent roads, construction of pipelines, and drilling. Such permits typically contain conditions or stipulations to protect fish, wildlife or vegetation resources.

An excellent example of oil and gas exploration in the area adjacent to the ANWR Coastal Plain has already occurred. An exploratory well was drilled in 1985-86 on Kaktovik Inupiat Corporation and Arctic Slope Regional Corporation lands about 14 miles southeast of Kaktovik. This is the only well that has been drilled between the Canning River and the Canadian border north of the Brooks Range. Construction and drilling operations were conducted in close coordination with U. S. Fish and Wildlife Service and included construction of an ice road and ice airstrip and a 5-acre drilling pad. Wildlife in the area were not affected by the operations. Construction of the ice road and airstrip began in December of 1984, the well was spudded in mid-February 1985 and drilling operations were suspended in early May of that year. The road and airstrip were reconstructed in late November of 1985 and drilling resumed. Drilling operations in the well were completed in April of 1986; timbers and foam insulation used under the rig are expected to be removed during the summer of 1986.



Production facility at Prudhoe Bay. *Standard Alaska*

Oil and Gas Activities

In the petroleum industry, there is an orderly progression of events from leasing to exploration to development; in ANWR the progression is expected to take about 15 years or more. These long lead times result from the remoteness of the region, concerns for protection of the environment, and the regulatory requirements. The long lead time also means that in order to evaluate fully the ANWR Coastal Plain's petroleum resources so they might compensate (before the year 2000) for the imminent decline in domestic petroleum production, exploration must begin as soon as possible.

Oil field activities fall into three phases: exploration, development, and production. The intensity of activity and the level of potential impacts to the environment are significantly different from phase to phase.

Exploratory Operations. Exploration includes surface investigations by geological field crews, geophysical (seismic) surveys, and exploratory drilling. Planning and permitting for an onshore North Slope exploration well, which is typically drilled during the winter, can take three to six months. Drilling time varies depending upon the depth of the well and other factors. The work may be accomplished without construction of permanent facilities. Roads and airstrips may be built of ice which will melt out by mid-summer.

Development. Once additional drilling confirms a commercial discovery, detailed engineering, economic, and environmental studies commence. During this time, a proposed project undergoes a thorough regulatory review which usually includes preparation of an environmental impact statement. Specific permits are required for most oil field activities including placement of fill, disposal of wastes, drilling activities, emissions from construction facilities, and so on. The highest level of activity occurs during the development phase as additional wells are drilled and camp and production facilities are constructed.

Production. Oil field construction activity wanes as production starts and the emphasis shifts from construction to maintenance activities. However, development drilling activity continues throughout the life of the field for secondary and tertiary recovery.

Protecting the Permafrost and Vegetation

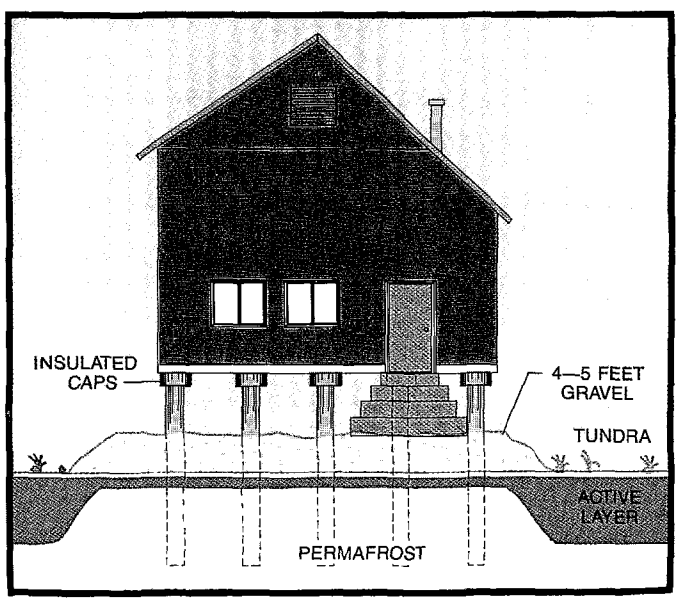
Numerous studies in Arctic Alaska have focused on tundra vegetation. This research has resulted in development of ways to conduct routine oil and gas exploration and production activities without significantly degrading the mat of tundra that insulates the permafrost. Consequently, there is now a large body of knowledge regarding tundra plant species, geomorphological processes, and the interaction of industrial activities and physical and biological dynamics in the region.

From the years of operating experience there has developed an environmental protection technology to minimize, and in some cases eliminate long-term changes to the tundra. For example, low-pressure tired vehicles have been developed which can cross the tundra without crushing the vegetative mat or scouring the soils as tracked vehicles might. Ice roads have been constructed to provide winter access to remote sites. These temporary roads provide dependable access to sites by heavy equipment; they melt during spring breakup leaving the tundra essentially as it was before the road was built.

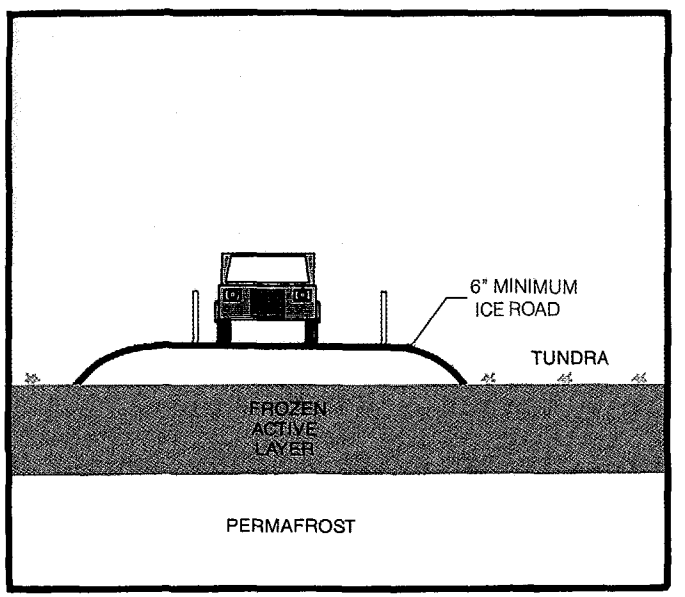
Although it is not an alternative for development, some single-season exploration drilling has been done from ice or snow pads in the Alaskan Arctic. Permanent facilities at Prudhoe Bay are constructed on gravel pads, and gravel roads have been constructed to provide access to individual production sites. Typically, 4 to 5 feet of gravel provide adequate protection of the permafrost. The gravel insulates the permafrost and provides a stable work area for drilling rigs and other facilities. In addition, heated buildings and warm oil pipelines are constructed on pilings to prevent thawing of the gravel pads and underlying soil. Continuous monitoring of these facilities and modification, when appropriate, have resulted in minimal impacts to the surrounding tundra vegetation and drainage patterns.

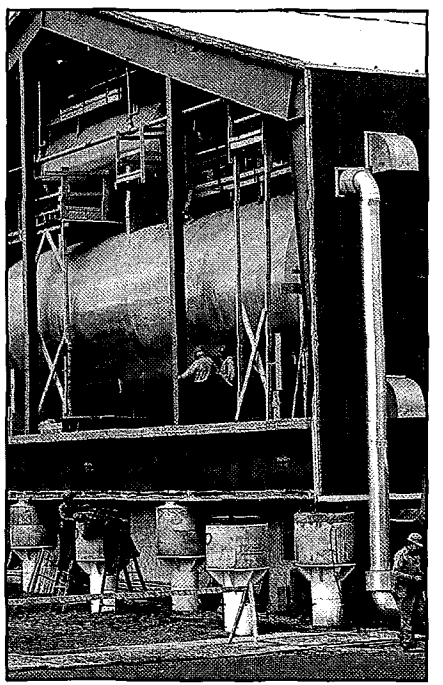
To reduce costs of development in the Arctic and to minimize effects on the environment, drilling and production technology has been developed to allow oil and gas production facilities to be concentrated into fewer locations. Within the roughly 250 square mile area of the Prudhoe Bay oil field, less than 10 square miles of land have been affected directly or indirectly by oil production facilities.

PERMAFROST PRESERVATION
GRAVEL PAD



PERMAFROST PRESERVATION
ICE ROAD



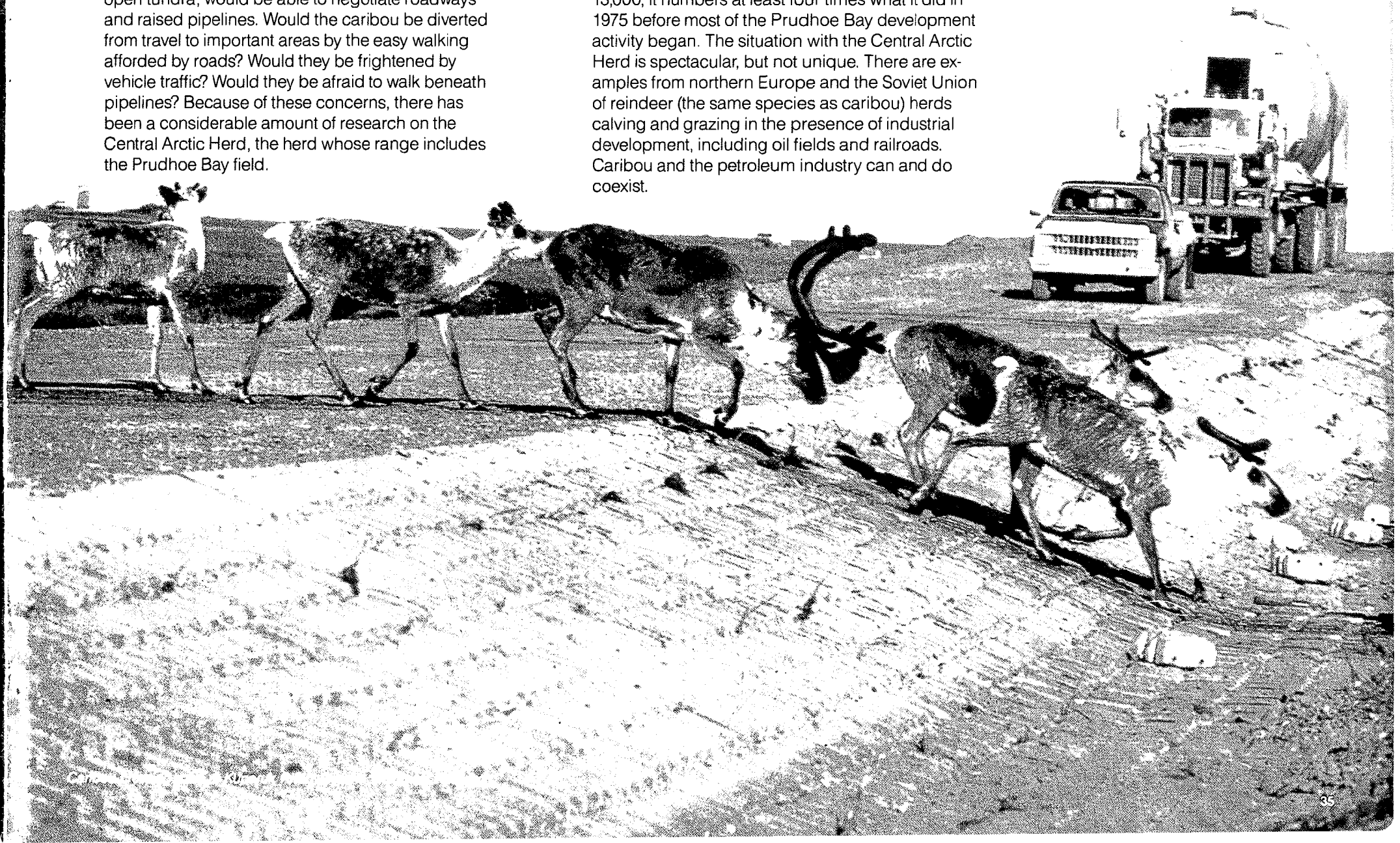


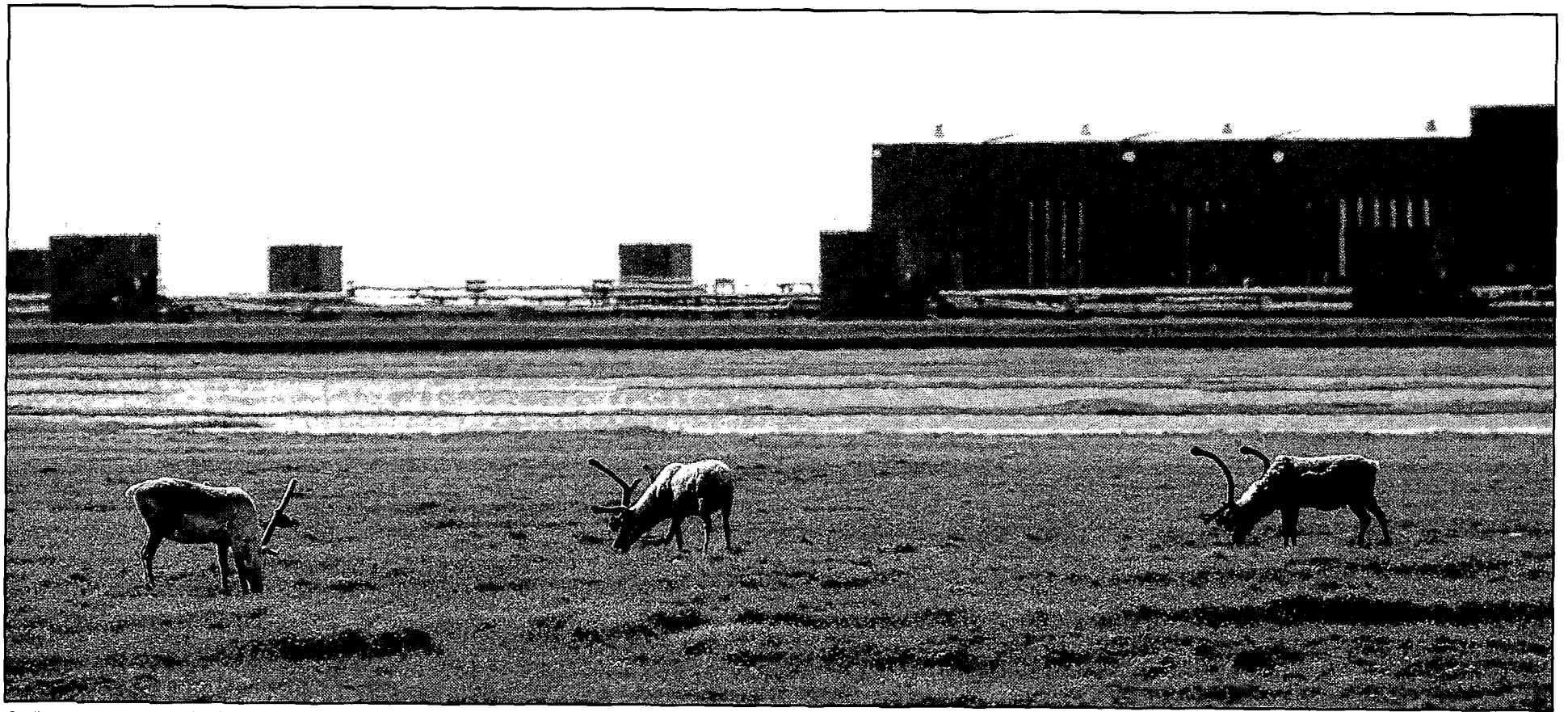
Installation of production module on pilings at Prudhoe Bay. *Standard Alaska*

Interactions Between Caribou and Oil Development

When the Prudhoe Bay oil field was developed in the mid-1970s, regulatory agencies acted cautiously and studies were conducted to determine the effects on the Central Arctic Caribou Herd. Early on there were concerns about how the caribou, accustomed to open tundra, would be able to negotiate roadways and raised pipelines. Would the caribou be diverted from travel to important areas by the easy walking afforded by roads? Would they be frightened by vehicle traffic? Would they be afraid to walk beneath pipelines? Because of these concerns, there has been a considerable amount of research on the Central Arctic Herd, the herd whose range includes the Prudhoe Bay field.

The experience with the Central Arctic Herd is of particular interest because of its proximity to ANWR. Perhaps the most striking fact about the Central Arctic Herd is that it has increased at a rate of 12-18 percent per year over the past decade. At more than 13,000, it numbers at least four times what it did in 1975 before most of the Prudhoe Bay development activity began. The situation with the Central Arctic Herd is spectacular, but not unique. There are examples from northern Europe and the Soviet Union of reindeer (the same species as caribou) herds calving and grazing in the presence of industrial development, including oil fields and railroads. Caribou and the petroleum industry can and do coexist.





Caribou graze near production facility at Prudhoe Bay

Mosquitoes are important determinants of how often caribou encounter oil field operations. When the caribou seek relief from mosquitoes, they travel rapidly north to the coast to take advantage of onshore breezes and return inland when mosquitoes temporarily subside. This movement pattern causes the Central Arctic Herd to frequently encounter oil field structures and 80 percent of pipeline-caribou interactions occur during mosquito season. In contrast, during the fly season, the caribou cannot find relief by seeking windy locations; at this time they often ignore development activities. When warble and bot flies are bothersome, caribou actively seek out roads, gravel pads, and the shade of buildings to gain relief from the pests.

Caribou tend to follow the path of least resistance when traveling, as long as that path leads to their destination. For example, they avoid swimming through lakes in summer, but move across frozen lakes during winter. They also tend to travel along land contours and along eskers (natural gravel features similar to gravel roadways). But they will negotiate more difficult terrain when this is necessary.

Caribou may hesitate crossing under an elevated pipeline and may choose a gravel ramp over the pipeline if one is present, but they often cross beneath pipelines. It is only the combination of an elevated pipeline and an adjacent road with moving vehicles that significantly decreases crossing success, but even under these circumstances crossing by caribou is not entirely precluded.

The concept of 'critical calving areas' has been a focus of some attention. Although caribou tend to calve in the same general region each year, within that broad area the caribou calve in different locations in different years. The experience of the Central Arctic Herd, which occupies the coastal plain to the west of ANWR and includes the Prudhoe Bay, Kuparuk, and Milne Point oil fields, indicates that industry operations within the general region have not affected calving success; this conclusion is supported by the continued healthy growth of the herd's population.

Interaction of Bears and Oil Development

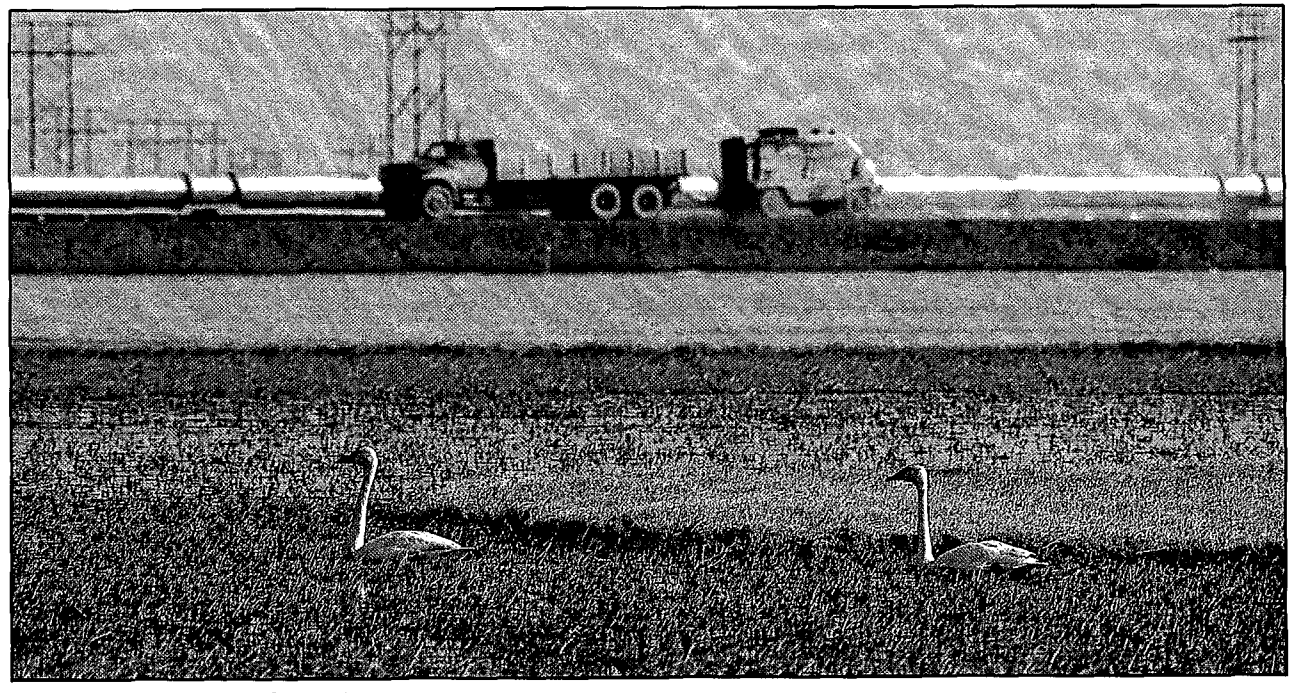
Grizzly Bears. The range of the grizzly bear in North America has contracted greatly with the expansion of human settlement. However, this change was not a retreat of the bears into more remote areas, but rather the consequence of hunting by man, related particularly to protection of livestock and people. Very often garbage was mishandled, creating an attraction for bears and the potential for negative encounters. Bear problems in the past were most often solved with a rifle. In contrast, in recent years bears have come to be highly valued and emphasis has been placed on preventing bear-human encounters. Much of the current knowledge has been gained from experience in national parks.

A basic element in protecting bears and avoiding interactions is to ensure that garbage is incinerated so that bears are not attracted by odors. Most encounters occur when people are walking near bears. However, oil field workers usually restrict their activities to the roads and gravel pads where the chance of unexpectedly encountering a bear is remote. Encounters with bears in the Prudhoe Bay area have been few and none has resulted in the death of a bear.

Polar Bears. Given the fact that polar bears in many areas den on land, it was formerly believed that pregnant polar bears probably denned in significant numbers on land in northern Alaska. But the recent information that nearly 90 percent of female polar bears established their maternal dens on the sea ice greatly alleviates the fear that winter operations in ANWR (or elsewhere on the North Slope) could significantly affect the polar bear population.

Interaction of Birds and Oil Development

Birds are abundant on the North Slope, particularly during migration and the summer nesting period. Experience at Prudhoe Bay indicates that the effects of development will be small and sometimes positive.



Tundra Swans in Prudhoe Bay wetlands.

The presence of roads has a local effect on bird habitat. Drifted snow near roads may not melt until late June or early July thereby locally limiting sites available to early-nesting species such as Lapland Longspurs and Semipalmated Sandpipers. On the other hand, dust from roads may cause earlier snowmelt, resulting in greater availability of snow-free habitat which may balance the temporary loss in drifted areas. Early in the summer season, the birds compete intensely for the limited space in the first snow-free areas. Birds that are unsuccessful at securing territories move onto the remaining habitat as the snow cover disappears delaying their nesting.

In flat, wet tundra areas such as those associated with the thaw lake plain, gravel roads may restrict drainage and create small impoundments. These impoundments provide additional habitat for species such as Northern Pintails and phalaropes but these impoundments may reduce the amount of habitat available to other species such as Lapland Longspurs, Buff-breasted Sandpiper, and King Eider. Changes in drainage patterns have been a focus of attention within the Prudhoe Bay development where there is little topographic relief. Consequently, detailed geobotanical maps classifying landforms, vegetation and drainage features have been prepared for Prudhoe Bay to provide the necessary information to locate facilities and route pipelines to avoid or minimize loss of the more valuable habitat and to avoid significant changes in drainage patterns. Changes in drainage resulting from construction of well pads are expected to be less of an engineering problem throughout most of ANWR where rolling hills result in well-defined drainage channels.

Oil field facilities, including pipelines and gravel pads, provide sheltered nooks and crannies that are used by some birds for nesting. In particular, Snow Buntings make use of new nest sites provided by pipelines and buildings.

Conclusion

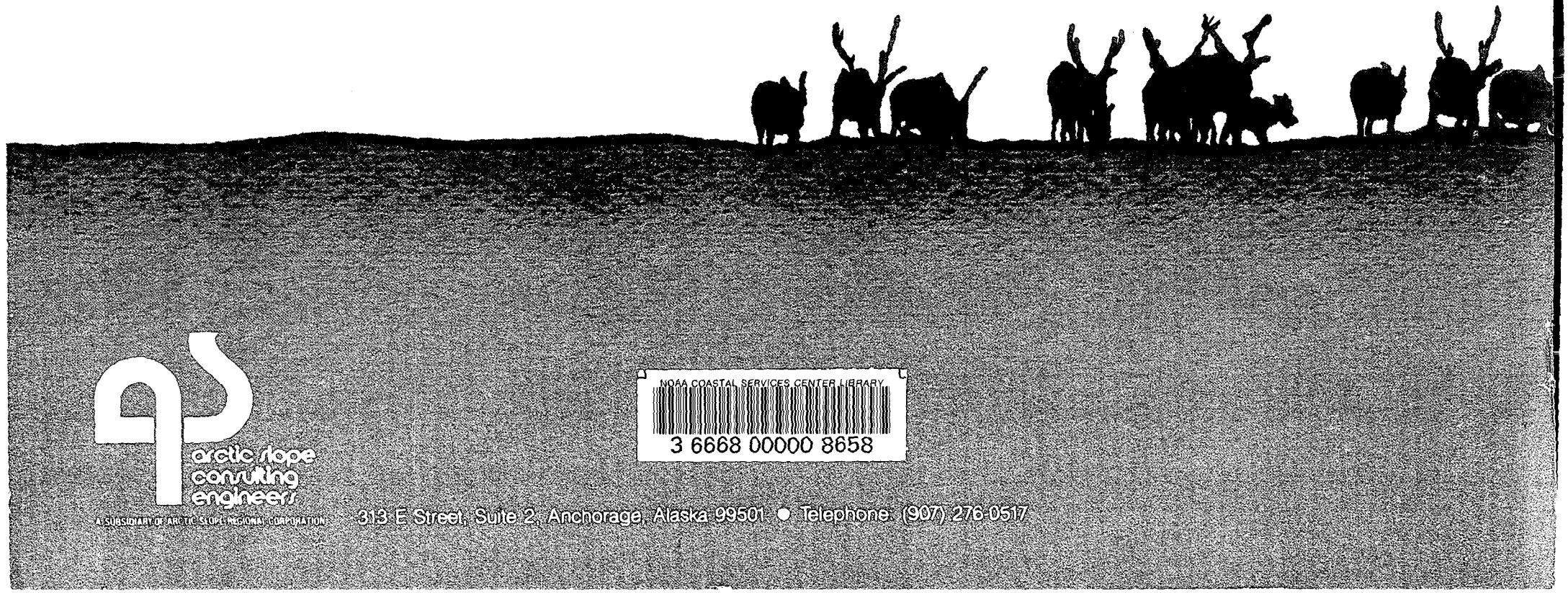
Less than 100 miles west of ANWR lies Prudhoe Bay, North America's largest oil field, located along similar geologic trends, which together with Kuparuk and Milne Point accounts for about 20% of U.S. domestic oil supply. Millions of dollars of research on wildlife resources and their habitat on Alaska's North Slope have not only immeasurably increased the scientific understanding of Arctic ecosystems but also shown that wildlife and petroleum development and production can coexist. Each year thousands of waterfowl and other birds nest and reproduce in the Prudhoe Bay and Kuparuk Fields and a healthy and increasing caribou herd migrates through these areas to calve and seek respite from annoying pests. Oil field facilities have been located and designed to accommodate wildlife and utilize the least amount of tundra surface. Experience gained at Prudhoe Bay and Kuparuk along with rapidly evolving drilling and production techniques will further minimize environmental impacts and surface use in future frontier Arctic petroleum provinces such as ANWR. Further, there has evolved over the past 20 years a sophisticated regulatory framework and permitting processes at the Federal, State, and local (North Slope Borough) level that requires measured, thoroughly researched and planned development activities focused on environmental protection.

The consensus of the geologic community is that the coastal plain of ANWR represents the onshore area of highest petroleum potential yet to be explored in North America. This potential is believed to be on the order of billions of barrels of recoverable oil and may rival that of the Prudhoe Bay field. Should leasing be permitted and subsequent commercial discoveries be made, it will be an estimated 15 years or more before oil and gas production from ANWR reaches

market. That production will then be urgently required by the U.S. Despite the current (1986) oil glut and decline in oil prices, the U.S. oil supply picture by the late 1990's could be bleak. Crude oil production from current reserves is projected to decline from over 8.8 million barrels per day in 1986 to less than 3 million barrels per day in 2000. Even with only a modest growth in U.S. crude oil demand the deficit in U.S. supplies will be on the order of ten million barrels per day which will have to be made up by new discoveries or imports. ANWR's contribution will therefore be critical to national energy needs.

The issue of oil and gas leasing in the 8% of ANWR represented by the Coastal Plain should not be considered, therefore, as an "either/or" decision with respect to preservation of important fish and wildlife resources. The record of other petroleum development on the North Slope supports application of multiple use management concepts in ANWR. Nevertheless, in issuing its final decision with regard to future management of the Coastal Plain of the Arctic National Wildlife Refuge, Congress will be faced with the problem of reconciling diverse goals of the national need for additional dependable energy supplies, the national need and interest in preservation of wilderness or nearly wild lands, and the promise (in ANCSA and ANILCA) to Alaska Natives regarding continued availability of subsistence fish and wildlife resources. These goals are not, however, mutually exclusive. Given the oil and gas exploration and production technology existing today, the ANWR Coastal Plain can be opened to leasing that is consistent with all these important requirements.

ANWR Coastal Plain. *USFWS*



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